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Track 1a: Current condition and future of basic research in universities – structural conditions

How do organizational factors and social capital affect research performance in changing academic settings? Review of the literature

1. Introduction

There is a long lasting science policy interest to understand what kinds of environments enhance the research performance of individual researchers. This interest is even stronger in current science and innovation policies, since they emphasize the importance of science systems as creators of knowledge-based innovations. Good research environments are a relevant topic also for scientists themselves who presumably want to work in functional rather than dysfunctional organizational settings.

Considerable amount of research literature has been published on the factors behind high research performance of researchers, in universities or elsewhere. Answers have been searched from both individual and organizational level. Some studies emphasize the importance of motivation of researchers: most motivated people perform the best (e.g. Andrews 1979). High performers also work a lot and have many tasks at once (Gulbrandsen 2000). Age and research experience have positive impact on performance up to a certain point, after which the impact starts to decline (Knorr et al. 1979). While individual level explanations and so-called “sacred spark” idea have sometimes dominated the studies on high-standard research work, there's also early evidence that individual factors are not conclusive: even the most eminent scientists' performance may vary in different organizational environments (Zuckerman 1967).

Discourse of “traditional” research work in universities usually refers to decades after the World War II, when the growing financial support from governments to science systems resulted in a

strong position of basic research in universities. Research was strongly motivated by goals of researchers, which in turn were affected by prevailing values of scientific community and fields of science. During the past decade or so, different concepts have been developed to describe the newest changes in (academic) knowledge production. Mode 2, Triple Helix, and academic capitalism are perhaps the best known of these concepts (see Gibbons et al. 1994, Etzkowitz & Leydesdorff 1997, Slaughter & Leslie 1997). In these accounts, some evidence is given to support the ideas that there are changes in funding, organization, practices, values and products of research. If the arguments about changes are correct, one may assume that the factors enhancing research performance could also be in flux.

In this paper I review the existing research literature concerning 1) research outputs of universities and, 2) the connections between organizational factors and social capital with research performance with the emphasis on university settings. I also analyse what is known about research output and the role of organizational factors and social capital in so called new mode of knowledge production. I also concentrate on available research on university research in Finland. This is because my paper serves the purposes of my PhD work, in which I explore the impact of organizations and social capital on research performance (productivity of publications and other research output, and quality of research) in academic medical and social sciences.

While reading research literature on organizations and research performance, one must remember that the studies explore to some extent different things. Sometimes the focus is on volume of output by research organizations. Measuring (article) publication productivity is quite typical. Sometimes the quality of research work is in the centre of analysis. Other studies may be interested in broader perspective and define performance as both the volume of outputs and the level and impact of research.

2. “Traditional” context of (academic) research work

2.1 Research outputs

Research on the forms of knowledge produced in universities is heavily concentrated on scientific output. An entire field of study, scientometrics, has developed to measure the growth and patterns in scientific publishing. Databases have been developed to record scientific publications, mainly journal articles. Some countries have their own publication databases. Since 1985, data on Finnish

universities' activity have been gathered to higher education database KOTA. Publication data are available in KOTA since 1994.

Twelve years ago the differences among disciplines were not so much between article publishing and book publishing, but between publishing in Finland and overseas, although book publishing was more common in humanities and social sciences. In sciences and medicine, the dominant form of publishing was "articles published abroad", in humanities and social sciences articles published in Finland. However, the dominance of national articles in humanities and social sciences was less clear than the dominance of international articles in sciences and medicine. (Auranen 2006) Kyvik's (2003) data from Norwegian universities from the beginning of the 1980s and the 1990s indicate similar publication patterns. Even in globally dominant science systems the scientific publication patterns among disciplines have been described to resemble those of Norwegian and Finnish academia, which suggests that these patterns have gone beyond national borders in developed science systems (Wanner et al. 1981).

There is no national level data collected on the universities' third stream outputs from the post-war era in Finland. Research is almost non-existent, too. Kaataja's research on patenting in two large Finnish universities, the University of Helsinki and the Helsinki University of Technology, is perhaps the only larger study on third stream knowledge production in Finnish universities. His results indicate the increase in the amount of academic patents during the years 1946-1985, but the patenting intensity (patents per working scientist) has remained low and rather steady in the same period of time (Kaataja 2006).

Although there is no proper data collection or research on commercial production in the Finnish universities from the post-war period, we can see that internationally commercial outputs from the universities haven't been absent after the WWII. Volume figures, at least at the national level, are still difficult to find. Research has been done mainly on the university patenting in the United States. Henderson et al. (1998) found that the amount of US university patents per year has risen rather steadily in the period of 1965-1985, starting from 96 in 1965 and ending up at almost 700 in 1985. The rise of patents was even faster in 1985-1988. Proportion of drug and medical patents rose the most in 1965-1988, other major fields being chemical, electronic and related, and mechanical. In a small European country the situation can be quite different. Saragossi & van Pottelsberghe de la Potterie (2003) show that in the period of 1985-1989 Belgian universities made only 17 patent applications, and in 1990-1994 23 applications. Research on post-war commercial output suggests,

though doesn't always say it explicitly, that it has been mainly the academia in the fields of sciences, engineering and medicine that have been engaging in commercial activity (Mowery et al. 2001, Martin & Etzkowitz 2000, Geiger 1988, Etzkowitz 2003, Baldursson 1995). This is also intuitively clear: research results in these fields are the easiest to commercialize.

Some Finnish studies touch the question of the uses and impacts of (university) research in society, especially public policy making (e.g. Hartikainen 1978, Lampinen 1992). In these accounts the knowledge produced in universities is usually not in the central role. Hartikainen reflects the various types of research in relation to governmental decision-making and development. One division of the types of research distinguishes between basic research, applied social research, and development work, which produce different kinds of knowledge. However, Hartikainen doesn't deal with the universities' role in regards to various types of research. Lampinen makes a division of three types of research, which reflects the situation in Finnish research landscape in the 1980s. Three types differ in their orientations and connect to certain institutional settings. Universities' role is the strongest in academic research, smaller in sectoral research, and smallest in technological research. Still, Lampinen doesn't provide any numerical data to support his division. Finland has certainly had its period of "social engineering", the attempt to plan the society with scientific information in the 1960s and the 1970s (Nieminen 2005). Period has probably had some impact on the knowledge production in the universities, mainly in the social sciences. What that impact is, is not clear. There is also some research on social sciences' role in the public policy making from other countries. Studies include for instance Lindblom and Cohen (1979), Webber (1991), and Weiss (1978), some of which concentrate more on the uses and impacts of social scientific research rather than its products. Like in Finland, the use of social sciences for societal needs appears to have partly been connected to the certain science policy phase (Ruivo 1994).

Despite the lack of national data collection, some Finnish universities have collected data on publication output that is not classified as "scientific publications" according the KOTA database guidelines. In some fields of science, mainly human sciences, the share of non-scientific publications appears to rather large (Auranen 2006). Kyvik's (1991, 2003) research on the publication behaviour in Norwegian universities refers to similar patterns. He has shown that in the beginning of the 1980s and the 1990s scholars in medicine and sciences oriented themselves less to popular science publishing than colleagues in humanities and social sciences. Popular science publishing can be seen as a form of output for civil society.

In conclusion, the rough picture of the third stream outputs across disciplines would be the following: commercial products in the universities have been the realm of sciences, engineering, and medicine, while humanities and social sciences have been more active in serving civil society and public administration. National and university-specific differences can of course be found. Commercial activity in universities has been and is influenced by national legislation, and in some countries the involvement in the public debate (output for the civil society) can be considered to a duty of the academia. There is also a history of technical and land grant universities, which have been active in knowledge and technology transfer long before the changes we are talking about now. (Azagra-Caro et al. 2006, Martin & Etzkowitz 2000, Van Looy et al. 2004)

2.2 Organizational factors, social capital and research performance

Organizational factors affecting research performance are manifold, including funding and other resources, unit or group size, student-staff ratio, diversity of tasks, diversity of people, autonomy of action, leadership, climate or culture, and communication. Of these, communication has often proved to be essential factor in successful research. Especially internal communication in groups and units is vital. (Gulbrandsen 2000, Pelz and Andrews 1978) Other factors are trickier. High-level research environments are not born just by having more of some factor that is needed in research.

In their classical study, Pelz and Andrews (1978) described eight creative tensions, under which they saw researchers working: science vs. application, independence vs. interaction, age and specialization vs. diversity, individual vs. organization, influence given vs. received, similarity vs. dissimilarity of peoples' ideas, broad vs. narrow approach of research and intellectual combativeness vs. collaboration. Their large study included researchers and engineers from industrial and government laboratories as well as universities in the United States, representing mainly natural sciences and engineering. The most effective researchers worked in environments that allowed them to balance above-mentioned tensions. For example, they participated in both basic and applied research, or were intellectually independent, yet communicated often with their colleagues. The ability to balance the tension was in some cases dependent on the age of researchers and research groups. Later, Gulbrandsen (2000) has used the ideas of Pelz and Andrews. He interviewed Norwegian eminent or "leading" senior level researchers from universities, public research institutes and industry about their views on organizational factors and research quality and creativity. His results are in line with those of Pelz and Andrews while he addresses partly different questions. Interviewees emphasize motivation, task diversity, balance of autonomy and

coordination, diversity of people while maintaining the common intellectual ground, and active internal and external communication, in which reciprocity of information exchange and trust between partners was important. Leadership was found to have an indirect influence: many interviewees saw good leaders as working in the background. There was no single optimal group or department size according to interviewees. Similarly, resource level was not seen as a critical determinant of quality: “enough” resources are needed, but more and more resources don’t self-evidently lead to high-quality research.

Another classical study on research organizations and performance is an international comparative study initiated by Unesco (Andrews 1979), where effectiveness of research units in university and industry sectors in six European countries were analyzed. Among the various determinants of effectiveness, position of the researcher, quality of leadership, size and age of the group, communication, and morale and motivation were linked to effectiveness. Some factors were found to interconnect, and there were also optimums of certain factors. For instance, perceived good leadership correlated positively with good climate in unit, which in turn was linked to effectiveness. Productivity and recognition of researchers tended to grow as groups grew bigger and older, but only up to a point. Different forms of communication were most strongly related to publication productivity, less to other dimensions of research effectiveness. Motivation was important to overall effectiveness, although its impact on different dimensions of effectiveness varied. Interestingly, there was more variation in motivation between units than within them. This indicates that motivation can be understood as a feature of a group. Of all the factors studied in international study, material resources were only weakly related to effectiveness, though a minimum level of resources is naturally needed. Human resources were more important, a finding in line with Gulbrandsen’s study, in which eminent researchers put much weight on finding the most talented and creative people to do research.

Possibility for collaboration in research is a factor that is partly dependent on an organization a researcher is based in. An organization with good collaboration contacts can be an asset for its researchers. Empirical studies support the conception, that research collaboration enhances productivity, at least in science systems of the developed countries (e.g. Price & Beaver 1966, Pao 1982, Lee & Bozeman 2005). In developing countries, costs of collaboration can exceed the benefits, as lack of proper infrastructure, for example IT facilities, hinder communication and coordination necessary for collaboration (Duque et al. 2005).

Researchers of social capital have defined the concept in various ways, but there is some consensus that social capital means networks of relations (among people) through which certain phenomena, such as trust, norms of reciprocity or fast exchange of information, become possible. These phenomena, in turn, make for example collaboration and communication easier and reduce the need to formal agreements and control. (Coleman 1988, Putnam 1993, Bourdieu 1986) As communication and collaboration appear to be vital organizational factors enhancing the performance of researchers, role of social capital in research environments becomes interesting.

Although social capital is considered to be a multidimensional phenomenon, empirical studies on social capital in organizations often concentrate on measuring the number and intensity of network ties among people or organizations. This may be due to difficulty in measuring trust, which is sometimes considered to be the most important element of social capital. Analyses of the connections between trust and innovativeness exist in business studies literature, but they often have no relation to social capital literature. In the following, I review heterogeneous body of research exploring the role of social capital and/or trust in R&D or firm innovation capacity.

Lazega et al. (2006) report, that organizational social capital is more important than personal social capital for the visibility of publications by the eminent French cancer researchers. Centrality of a laboratory in a network of laboratories exchanging information, personnel and material was found to correlate more strongly with researchers' visibility than individuals' centrality in networks of mutual advice. Reagans and Zuckerman (2001) emphasize the heterogeneity of firm R&D teams, as it enhances teams' productivity. If senior and junior members of a team communicate a lot, team is more productive than teams with less intense communication between senior and junior members. On the other hand, intense internal communication as such raises the productivity of a team.

Landry et al. (2002) observed, that firms' willingness to innovate is explained by structural dimension of social capital, which was measured by participation in business meetings, associations and networks, as well as intensity of personal network ties between firms' employees and outside actors. However, high trust between employees and outside actors was not connected to willingness to innovate. Radicalness of innovations and some structural elements of social capital were linked. If firm pursued radical innovations, it considered research networks very important. Ruuskanen (2004) studied the connections of social capital and innovativeness in Finnish small and medium sized companies. Number and intensity of firms' network ties correlated positively with innovation activity, as well as managers' participation in business associations. Trust was not significantly

related to innovation activity, but on the other hand, less innovative firms didn't participate in networks, as they wanted to protect their know-how. In a sense, these firms didn't trust the other. Sometimes trust in (R&D) organizations has been studied separately from the concept of social capital. Ellonen et al. (2006) have analyzed the role of both interpersonal and organizational trust in firm innovativeness. Data cover Finnish firms in ICT and paper industries. Results indicate a positive impact of institutional trust (employees' trust in benevolence and performance of their firm) on all aspects of innovativeness. Vertical trust (employees' trust in benevolence and performance of the leaders of their firm) enhances behaviour innovativeness (openness to new ideas and innovation). Trust between employees was not connected to innovativeness. Oh et al. (2004) studied the impact of group social capital in various firms in South Korea. To be most effective in its work, group needed to have a moderate level of intensity in intra-group informal ties. Furthermore, effectiveness increased the more group members had informal ties to leaders of other groups. Through the glance at history, Cohen and Fields (1999) describe the nature and benefits of social capital in Silicon Valley. Trust in Silicon Valley is trust in performance of others, which is based on reputations of somebody being a good and competent employee or a business partner. Another important factor of social capital is fast access to newest information through network ties. This has helped the firms to adjust to the changes in market and speed up their innovation processes.

3. Current context of (academic) research work

3.1 Research outputs

In respect to forms of research products, the Mode 2 argument says that the overall growth of social accountability of research results in researchers creating all kinds of socially applicable knowledge and products, not just commercial ones. Academic capitalism argument concentrates on the rise of commercial output in the universities, as well as Triple Helix literature.

Paasi (2005) has argued that there is a process towards homogenisation in the scientific publishing cultures. Background of the process is the higher education policy shift towards accountability, output orientation, and demand for "international world-class research" in many countries. As a result, forms of scientific publishing begin to resemble each other across academic fields and countries, final stage being that scholars all around the world will publish articles in English-language journals, mainly based in the US and the UK. Paasi focuses his analysis to the publishing

places of scientific journals in ISI database. These journals are in many cases regarded as a synonym for “scientific publishing”. Paasi shows that most of the journals in ISI are published in the United States and the UK. Thus, to be “international” in science is to publish in English-language journal, published in either one of the above-mentioned countries. Homogenisation in publication cultures can be seen as part of commodification of knowledge. Knowledge is becoming part of the global science and technology marketplace. (Jacob 2003, Slaughter & Leslie 1997)

The development in Finnish universities’ scientific publishing gives some support to Paasi’s argument. From the end of the 1990s there has been a gradual decrease of publishing in books in four large main disciplines. Article publishing is becoming more international too (Auranen 2006). However, data from KOTA don’t say anything about the language of the publications published outside Finland. Furthermore, social scientists’ and humanists’ main publication forums are still articles published in Finland. Still, the change in publication behaviour is more visible in social sciences and humanities than in other main disciplines, since they were previously more oriented to book publishing. Again, situation in another small science system is similar. Kyvik (2003) has showed how publication behaviour in Norwegian universities has become more uniform during the last 20 years. At the end of the 1990s, Norwegian social scientists and humanities scholars published more in other than Scandinavian languages and in journals than before. The shift from book to journal publishing is slower than the shift from publishing in Scandinavian languages.

From the small country perspective the UK science system appears to be in the centre of scientific activity and publishing. Yet it seems that it has its own pressures to be more international. Some have argued that the UK Research Assessment Exercise (RAE) has transformed publication cultures to suit the demand of “international excellence” in research. The percentage of journal articles has grown among the publications submitted to RAE between the 1996 and 2001 assessments. The assessment values more high impact journals mainly published in the US and the UK, which may direct the scholars to target their publishing efforts to only a limited group of journals and to avoid other forms of publishing. (Bence & Oppenheim 2004, Walford 2000)

With regards to third stream knowledge production, the research on the changes has been concentrating on the possible growth of commercial output in the universities. Meyer et al. have recently (2004) studied patenting in Finnish universities. During the 1990s, 432 of the US patents originated from Finnish universities, on the average about 43 patents per year. With these data, it’s impossible to say whether patenting activity in Finnish universities has grown. According to Meyer

et al., patenting was strongly concentrated on few universities in the 1990s. This refers to the fact that commercial activity wasn't very commonplace during the last decade.

Research from other countries also gives support to the conclusion that commercial outputs haven't significantly replaced scientific output. There is growth in commercial production and possibly other forms of output besides patents are becoming more widespread. But at the same time scientific publishing has also grown fast. (Nelson 2001, Corolleur et al. 2004, Godin & Gingras 2000, Ranga et al. 2003) Scientific and commercial productivity concentrate on the same people and results in a "compounded Matthew effect" (Van Looy et al. 2004, Gulbrandsen & Smeby 2005). Commercial activity appears still to be mainly the sphere of sciences, engineering, and medicine. Social sciences and humanities are not affected by the new knowledge production with regards to commercial output (Albert 2003). Nor is their role very well realized in the research on the new knowledge production (Scott 2000).

There are few studies in Finland describing the presence of civil society and public administration as the audiences of university research. Hakala and Ylijoki (2001) identified Work Research Centre in the University of Tampere as unit concentrated on producing research results for the purposes of public administration. Department of History in the same university still cherishes the tradition of popular science writings and lectures in addition to scientific output. My own small case study (2004) implies that the awareness of audiences in addition to academia and the knowledge production suitable for these audiences can be higher in some more recently establish academic units which have epistemic roots also in humanities and social sciences. Despite these efforts, we are still in need of national level data on the volume of third stream activities. By looking at the development in other than scientific publishing in the University of Tampere in 1998-99 and 2003-04 we see no indication that the proportion of third stream activity is growing (Auranen 2006). Result is not surprising given the conclusions of Ylijoki's study (2003). Despite the changes in organisation of university research and overall working conditions, the persistence of traditional academic values among the Finnish academia seems remarkable. Scientific truth, doing "pure science" and the symbolic capital gained with it, are still highly valued.

3.2 Organizational factors and research performance

Writers of the New Production of Knowledge suggested that in the sphere of new knowledge production, new forms of organization also evolve. Inventors of Triple Helix concept have

expressed similar views. Hemlin (2000) has studied the organizations of new mode of knowledge production within and in vicinity of universities. He concludes that some features of organizations and their activities are in line with the arguments made by Gibbons et al. and Etzkowitz. Reward system and leadership were more traditional, while communication, organizational structures, production forms and outputs showed signs of new type of knowledge production. In the interviews with the employees of “Mode 2 type” intermediary organizations, the importance of intense communication with various partners came up. Organizations were loose and network-type, projects were common way of organizing work, and climate an important factor for employees. (Hemlin 2000)

We seem to lack empirical studies on factors behind good research performances in these new type of research environments. This may be partly due to the fact that new types of organizations are still marginal. Hemlin has studied (2006) the determinants of high performance among Swedish research groups in biotechnology, a research field with commercial potential. High performing university groups were characterized by working freedom for individuals, encouragement for presenting ideas, and also orientation to producing innovative products. Good leadership is possibly ever more vital: Hemlin concluded that excellent academic research groups appreciated leaders with good problem solving skills.

There is also evidence for increasing relevance of networking in “Mode 2” and a need for scientists to establish connections to users of knowledge, financiers, and research collaboration partners outside academia. Shove (2000) describes the new climate among British academic social scientists after the government White Paper on science policy in 1993. She focused on research unit managers’ efforts to become and stay known in non-academic circles. They constructed personal ties to policy makers, industry and media in order to secure funding and other resources. Reputations of managers and their units among various users of knowledge, embedded in personal networks, had become important assets. Unit leaders saw multiple funding sources as an important factor of successful research. Shove’s interviews also indicate that success of units is more dependent on managers’ leadership skills than before, as environment has become more complex.

Also Harvey et al. (2002) emphasize the role of strong leadership in their study of high performing medical and medical-related research groups in the UK universities. Leaders provided resources, created good contacts, and recognized innovative trends to be part in. As in older studies, human resources proved to be important: groups must find, keep and develop talented people. Another

finding in line with older studies was the importance of connection between basic research and clinical practice. Groups had expanded their activities to some new areas that are close enough to core activities, which created financial and competitive advantages. Finally, as in the case of social scientists in the UK, creating and maintaining network ties inside and outside academia was considered crucial. It was both the resources and trustworthy research partners – known for their good performance – the members of the groups were after.

4. Conclusion

Based on the literature reviewed to far, the following conclusions on academic research outputs can be made. Division of knowledge produced has been between the types of scientific publications in natural sciences and human sciences. Natural sciences have been closer to commercial applicability, while third stream outputs of human sciences have concentrated on popular, non-scientific publications. While the number of commercial products has increased in past 15-20 years, it has not replaced or even decreased scientific publishing. The real change has happened in the nature of scientific publishing, which has become more uniform. However, not much is still known about research outputs besides scientific publications in past or current university contexts.

In the case of organizational factors and research performance, classical studies refer to importance of maintaining the balance of different factors. Freedom and coordination, size and age of a group, combining the activities of basic and applied research need to be in optimum state. Good leaders are needed to create good working climate. Human resources, calibre of the research staff, are more important than physical resources. Time and time again, studies have proved intense communication vital, as well as collaboration in research. Implication is that social capital enhancing communication and collaboration is vital too. Network configuration (how many and who do you know, and how well do you know them) appears to be more important than “basic-type” of trust, trust in other party’s benevolence. Instead, trust in performance of others, and in leaders and organizations are relevant for good performance.

In the current phase of university research, networks, communication and leadership seem to be increasingly significant. As the environment of funding and knowledge use is often more complex, network configuration needs to be updated for a group to success. Despite the rise of new factors, studies on “new” type of research environments also support some results from older studies.

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