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The competitive funding of university research: the case of Finnish science universities

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Abstract The present European higher education policy and research policy can be characterized as emphasizing external financing of universities, competition between and within universities, and the need for a more practical and economically profitable output from research and education. A theoretical framework of analysing the impacts of this new rationale can be constructed on the following two premises. First, the funding structure of universities and university research is a main factor that influences the situations in which universities and their members make their decisions on teaching, research and administering. Second, universities consist of various groups of personnel each having and developing objectives and preferences of their own. This theoretical framework is applied to the Finnish science university system. On the basis of the analysis it can be seen that although the new policy probably has clarified the division of labour between universities, there have emerged some negative unintended consequences of the new funding structure. Indications of weakening performance in research and education can be identified in the empirical analysis.

Keywords Funding of universities · Higher education policy · Science policy · Economic analysis of higher education and research

Introduction

The European universities have been confronted by the changes in the university funding structure and research policy rationale after 1980. The changes have fostered the significance of external, competitive financing and the idea of universities and university research as actors of economic development and success. Although the process, where the proper role for universities becomes refined, is still going on, we can learn some important lessons by careful studies of the general and specific features of the past development in Europe and in different countries. An important question is, whether the incorporation of quasi-

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market and competitive elements in the regulation of universities has generated only intended consequences or have there emerged also some serious negative unintended consequences?

In this paper we concentrate on the Finnish university system in order to find out how universities in Finland have reacted to the changes in their operational environment during the past 12 years.[1] It seems that Finnish universities have developed towards two separate directions regarding the use of available financing to the production of research, degrees and development services. Although the development has clarified the division of labour among Finnish universities, there are also some possible failures in the development. An indicative of this failure may be the weakening of the research performance and the loss of productivity in producing new knowledge. The analysis in this paper aims to analyze empirically both the changes in the funding of universities and the changes in the performance of the universities in producing education (measured in degrees) and research (measured in scientific publications). The analysis is conducted both at the aggregate level and at the level of university groups.

The study finds its topicality in the active discussion among researchers and policy makers on the current state and on the future role(s) of universities. A shared view seems to be that the *social contract of universities* has been changing during the 1980s and 1990s from a *post-war contract* towards a *revised contract* (see Martin 2003). The former one is characterized by public financing of basic science that the researchers themselves (or their representatives in research councils) find worth of pursuing. The so called linear model of innovation is often associated to this contract: basic science, it is suggested, proceeds to applied research and then to development and commercialization (Wesley et al. 2003). The revised contract, on the other hand, incorporates the ideas of increasing competition for financing, tighter financial constraints of the government and the fact that the government, firms and other members of society now expect more specific and rapid outcomes and benefits from investments in science and universities (see Martin 2003, p. 12). Clark (1983) has described this shift in terms of 'state-oriented systems' and 'market-oriented systems' and he recently (2003) emphasized the importance of analyzing the impacts of the diversified funding base of the universities. For example, one can expect a diversity of effects due to new financing agencies which have introduced into the funding negotiations and processes new objectives and preferences distinct from the traditional academic interests and objectives.

A threat often associated to the new rationale of the revised contract is the possibility that the competitive financing mechanism may operate in a biased way. This would mean that resources for research may become allocated in a sub-optimal way—for example, to groups not most capable of performing the research. Furthermore, the resources may be funnelled to research satisfying short-term needs of practical knowledge possibly eliminating the long-term interests including the scientific principles and processes whereby knowledge becomes more corroborated. Empirical evidence is not, however, straightforward. Looy et al. (2004) found, in the case of one university (KU Leuven, Belgium), what they call a 'compound Mattew-effect' which means that researchers who had been able to get resources for problem-oriented research and development were also able to get resources for purely academic research. This suggests that public funding and private

[1] Finland serves as a representative example of the small north-west European and Scandinavian countries who invest much in academic research and have comparable large outputs (Pavitt 2001, pp. 5–6). This is accompanied by higher than the OECD and EU averages in investments in higher education measured as percentage of GDP (OECD: Education at a glance 2006. Table B2.1b (www.oecd.org/edu/eag2006)).

funding are, under certain circumstances, complements to each other. Laudel (2006), on the other hand, raises the question of the biased funnelling of resources in the context of grant acquisition: other factors than quality and excellence have a remarkable role favouring the richly funded researchers and groups. If this is the case, the complementarity may, indeed, increase the possibility of the sub-optimal allocation of resources. From a different perspective, Liefner (2003) compared six acknowledged universities in four countries[2] and found that the link between the funding structure and long-term performance is very weak. Furthermore, the professors in these universities saw that faculty qualifications and students' ability rather than funding pattern with monetary incentives are the most important factors of success both in research and in education. This suggests, as implied by Liefner's discussion, that, in a national university system, there may be few universities performing well independently of the funding structure, and that they are accompanied by several other universities acting, possibly, more responsively to the changes in the funding structure. This view is partly supported by Bonaccorsi and Daraio (2008), who show that in some countries (the UK in their sample) industrial funding and research efficiency are positively correlated but in some other countries (Portugal, Spain, and Switzerland in their sample) this is not the case. In addition, one-country data (Italy) shows, first, that the research performance of many universities is intact by the level of industrial funding and, secondly, that in the cases where the performance is influenced by the level of funding, the relationship is inverted U-shaped rather than linear (Bonaccorsi et al. 2007). At higher levels of industrial funding it may be that short-term goals, biased allocation of funding, or restricted diffusion of knowledge may degrade research performance (ibid.).

Another threat is related to the educative function of universities: it may be hard for universities to combine the educative function and the funding of education to the new incentives and constraints of research activities. This is associated to the perennial discussion on the topic of teaching versus research, but it also has a bearing on the current debate on the steering of universities and on the strategic decisions of universities to concentrate either on research-orientated, educational, or industry-orientated tasks with deliberated priorities among regional, national, and international fields of competition and collaboration (see Teichler 2008). At a departmental level the discussion is often linked to the massification of university education and to the increase of the teaching load of academicians. Many studies and international comparisons show, however, that there has been no clear relationship between the increased student-staff ratio and the teaching load (Smeby 2003). Nevertheless, there may be differences between universities and between scientific fields, since departmental level contextual factors, such as co-operating climate, age structure, and the proportion of faculty members with PhD, have been found to have influences on research activity (Smeby and Try 2005). Differences may also result from the organization of work at the departmental level. For example, some units may negotiate on the allocation of teaching load among the members of the staff whereas some other units provide the possibility to hire doctoral students as teaching assistants. A salient perspective in the recent literature points to the possibility of identifying the factors which define whether there are trade-offs or synergies between teaching and research (see Del Rey 2001; Gautier and Wauthy 2007) and how well they can be taken into account in the strategic decisions of universities.

[2] They are ETH Zurich and University of Basel in Switzerland; University of Twente in The Netherlands; University of Bristol in Great Britain; and MIT and UT Austin in the United States.

From the utility maximizing approach towards an institutional analysis of university behaviour

As indicated by our short discussion on the new social contract between university and society, universities are nowadays seen as institutions whose aim is to produce various outputs that are useful for the different parts and functions of societies and their members. The operation of universities is based on specific and changing institutions (habits, norms, and laws), incentives and the structural features of the organizations including objectives and preferences of the academic labour force. Two major 'economics of science' perspectives can be applied to analyzing modern universities. In this paper, we have adopted what Geuna (1999) calls institutional analysis of university behaviour. This approach outperforms in some important respects the standard utility maximizing approach the major shortcomings of which are as follows (ibid., pp. 15–17):

- the utility maximizing approach unifies the many targets of a university into one single objective function;
- the utility maximizing approach assumes that universities operate under competitive market circumstances;
- the analytical apparatus of the utility maximizing approach presupposes the existence of a long-term equilibrium.

The first shortcoming is the failure to identify and analyze the consequences of the fact that a university consists of various personnel groups—that is, teachers, researchers, and administrative staff, for instance (ibid., see also Campbell and Slaughter 1999). Each of these groups may have their own preferences and objectives. The new rationale for universities has meant that even more subgroups with different preferences have emerged when universities have taken charge of new tasks such as further education, collaboration with firms and industries, technology transfer and invention protection.

Regarding the other two shortcomings it can be argued (Geuna 1999, p. 17) that although competitive elements have emerged in the European university policy, universities operate in circumstances far from competitive market model and that European universities are in the middle of a large process of change rather than in a long-term equilibrium. Therefore, the standard utility maximizing approach really seems to be inapplicable to the present situation.

Theory and its implications

In outlining his institutional-analytical approach Geuna (1999; see also Geuna 2001) puts the diversified preferences and objectives within a university in the center of his analysis.[3] Hence, in studying a European university one should pay attention to the implications of the fact that a university consists of a variety of objectives and preferences. On the other hand, it is also important to see the emergence of new financing agencies with different objectives and preferences than traditional research council financing agencies (see Benner and Sandström 2000). Then, these factors may explain why in another university or in another time the responses to specific changes in the financing structure and the regulative environment may differ so much from each other. In other words, the aim in the analysis is

[3] See also Campbell and Slaughter (1999), who analyze the differing objectives and preferences both between faculties and between faculties and administrators.

to see the configuration of a country's university system into different groupings having their own strategy in connecting financing and other inputs in producing a mixture of outputs.

In applying his theoretical framework to European and British universities Geuna (1999; see also Slipersaeter 2007) provides some principles of the empirical assessment of the framework. Hence, in order to maintain certain generality and comparability across the countries the empirical measurement should be based on the available data which usually consists of data on the number of students, academic staff as well as on outputs such as degrees and publications. On these data one is able to construct variables of volumes and proxies of productivity. These variables should then be sensitive to differences between universities. A case in point here is the influence of the financing structure on the behaviour of a university and its personnel in different occupations. In other words, if the university gets a growing share of money from industry companies, does it influence on the behaviour of the academic staff in a way that can be identified by studying volumes of publication and productivity in publishing.

From this theoretical perspective we can draw the following implications:

(1) *Concentration of resources*. The new financing rationale, which emphasizes competitive financing, aims to a higher concentration and selectivity of resources so that scale economies can be utilized and the needs of the economy and society can be addressed. There are, however, some possible negative influences which can outperform the positive ones. *First*, external financing may increasingly benefit large and renowned universities and research teams with the consequence that research there gets financing more easily than research in smaller and less renowned sites. There is also some evidence that size and agglomeration effects do not work in the way policymakers have expected (Tunzelmann et al. 2003). If there is some misallocation of the external financing in general, then it would mean that the overall research activity and productivity will decrease.[4] *Second*, there may be some substitution effects where the lack of adequate financing of preferred research compels academic people to increase either his/her teaching load or to apply financing for other things than traditional academic research. *Third*, as Geuna suggests, the fact that universities often price their contract research projects according to the marginal cost pricing principle means that fixed costs have to be covered on other funds which again may decrease the performance of the universities both in producing degrees and research.

(2) *Conflicting incentives and the accentuation of the short-term research*. Many writers have referred to the accentuation of short-term research due to the increase of competitive financing—especially due to the very specific nature of commercial and industrial financing. It has been argued that (i) the market-money presupposes that the outcomes of research come quickly and that the researchers worth of financing have proved to be capable of producing usable outcomes in short time-limits. This would mean that long-term research as well as risky research projects and research that brings new paradigms to academic research becomes threatened (Geuna 1999; Pavitt 2001). This can mean that the universities geared towards more applied kind of research are able (or willing) to produce less academic journal publications. On the other hand, the universities aiming at more traditional academic research have

[4] The notion of negative *effects of the decline in research publishing* is not clear and it lacks systematic empirical evidence. One line of argumentation would lean on the social rate of returns of investing publicly funded research (see Salter and Martin 2001).

different distribution of incentives and are able (or willing) to produce more academic journal articles.

Finnish higher education policy in the 1990s: more autonomy with increased external financing

In Finland the idea of the revised contract between universities and society came up in the late 1980s. It first appeared in regulating universities on the basis of their performance in producing key outputs. Universities were expected to pay more attention to their outcomes and promised more autonomy as an exchange (Saarinen 2005, p. 7). In the beginning of the 1990s government financing of universities was based mainly on degree targets and degrees awarded. At the same time the share of external financing of total operational expenditures started to grow rapidly and the role of 'competitive financing' was strengthening. Hence, if the Finnish university system in the middle of the 1980s was perhaps the most centrally planned one in whole Europe (Hölttä and Malkki 2000, p. 233), the next decade meant quite a strong reformulation of the system. As has been stated, also the Finnish policy emphasized the need for interacting with and impacting on the business and industries.

As noted by Välimaa (2004) the understanding of the present Finnish university system presupposes some knowledge of its historical peculiarities. These include the following 20th century social forces: (i) political struggle between Finnish speaking and Swedish speaking Finns; (ii) rapid industrialization and related needs of the labour market; (iii) academic drift; (iv) regional higher education policy; and (v) the building of the welfare state. The two last mentioned 'forces' have a bearing on the analysis on this paper—they also highlight the quite rapid change in the policy at the turn of the century. That is to say, the present key phrases are 'information society', 'innovation economy' and 'competition'.

The regional higher education policy in Finland means that universities are regionally dispersed and aimed to serve the educational and development purposes of all geographical areas in Finland. Today, there are 16 science universities, four art academies, and more than thirty polytechnics in Finland. Officially, the aim of universities is to conduct free research and provide higher education based on research whereas the target of polytechnics is to provide education, research and development based on the requirements of working life (Ministry of Education 2006). Recently, more demands are set on universities to contribute directly to business and industry development which has stirred the division of labour between universities and polytechnics. The clustering of science universities presented in the next section does not exhibit, however, any clear parallelism between the profiles of the universities and the regional configuration of them.

The Finnish university system, which was constructed alongside the construction of the welfare state between the 1960s and 1980s and was based on expanding resources, changed dramatically in the 1990s. As Välimaa (2004) states, the higher education budget was frozen in 1992 (to 1991 level) and cut in 1993. At the same time external financing (from private and public sources) grew fivefold (from €102 to €521 million) between 1991 and 1999 (ibid.). The new University Act (1997) increased the internal autonomy of universities and the performance based government public financing was interwoven into the internal allocation of finances in universities. The increasing significance of competition was, in other words, brought inside the universities, even inside the faculties and departments. Alongside with this, the number of researchers working on the basis of fixed-term contracts increased dramatically due to the increase of external financing (ibid.).

Currently, the Finnish government is preparing a new, quite profound, reform of its university system and policy. The general means of improving the performance of universities are still the increasing of the autonomy of universities and competition between and within them. In addition, the legal status of Finnish universities will change in the beginning of 2010 towards more independence from state budgetary. The new policy tries to solve the problem of ever tightening budgetary funding by making universities to attract more private funding and to find cost savings. In consequence, the government has encouraged universities to merge and agree on formal collaboration with a view to concentrating resources and activities and reducing large diversity. Some universities are already on their way to merge or start formal collaboration in the becoming years. These new developments are related in an intriguing way to the picture which emerges from the impact of the past funding pattern on the Finnish university system. Some comments on these new trends will therefore be presented in "Discussion" section.

The change in the financing structure and its influence on Finnish science universities

Data and variables

In this section we study some hypotheses derived from the above theoretical framework. The data is collected from the KOTA data service[5] which is maintained by the Ministry of Education and which contains data on universities from 1981 onwards. However, the data related to some key variables in this study were entered into the database not until the 1990s. Regarding the changes in the financing structure, the data concerning the total sum of external financing goes back to 1983 while the full details of the sources of the external financing were entered not until 1999. However, since the total external financing data series goes back to 1994 we are able to produce a cluster analysis on years 1994–1995 and 2004–2005 on the available data and have comparability to Geuna's (1999) analysis based on European and British data. Some additional analyses are based on a shorter time period starting from 1999. They key *basic variables* are:

- total external financing (TEXF);
- external research financing (ERF);
- total government budgeted operational expenditures (salaries, premises and other) (TOPE);
- Academy of Finland (research councils) financing (AFF);
- domestic industrial financing (IF);[6]
- Tekes financing (TF);[7]
- published articles (refereed) in Finland and abroad (PUB);
- budget-funded teachers (BFT);
- research personnel (RES);
- students (all degrees) (STU);
- Master's degrees (MD);

[5] http://kotaplus.csc.fi:7777/online/Etusivu.do?lng=en.

[6] Termed in the KOTA database as 'domestic companies'.

[7] Tekes (Finnish Funding Agency for Technology and Innovation) is the major public funding organization for research and development in Finland. It finances industrial projects as well as projects in research organizations, and especially promotes innovative, risk-intensive projects. It has a more applied research profile than the Academy of Finland.

- doctorates (DD).

Various grouping variables and variables entered in the analysis in the later stages are computed from these basic variables. The key grouping variables are:

- published articles per academic person (PUBAP = PUB/(BFT + RES);
- share of external research financing of total budgeted operational financing plus external research financing (SHEXT = ERF/(ERF + TOPE) * 100);
- academic persons per student (APERSTU = APER/STU; APER = BFT + RES).

The main variables entering in the later stages of the analysis are:

- share of domestic industrial financing of total external research financing (IFSH = IF/ERF * 100);
- share of the Academy of Finland financing of total external research financing (AFSH = AF/ERF * 100);
- share of the Tekes financing of total external research financing (TFSH = TF/ERF * 100);
- Master's degrees per academic person (MDPER = MD/APER);
- doctorates per academic person (DDPERS = DD/APER);
- marginal productivity in publishing $(\mathrm{MPPUB} = (\mathrm{PUB}_{2005} - \mathrm{PUB}_{2000})/(\mathrm{AP}_{2002} - \mathrm{AP}_{1997})$.

The research questions

The empirical research questions are derived from the theoretical framework outlined in the previous section and referred to with the expressions *concentration of resources* and *conflicting incentives and the accentuation of the short-term research*. The emphasis is, as stated, in the research behaviour of the universities. The research questions are as follows:

(1) Are there, in terms of the key grouping variables, various clusters of universities in Finland?
(2) How did the clustering change from 1994–1995 to 2004–2005?
(3) How did the 'upgrading' and 'downgrading' universities perform regarding research and education?
(4) Did the activity and productivity of publishing decrease in Finnish universities from 1994 to 2005?
(5) Can we say anything of the causes of the overall weakening of the research performance of Finnish universities?

The change in the Finnish financing model: the increasing significance of external financing

As described above, during the 1990s there have been two major changes in the government policy and regulation towards universities in Finland. The *first change* was the beginning of the growth of external financing after the economic recession at the turn of the 1990s when the expansion of the higher education budget first was slowing, then was frozen at the level of the previous year and then, in 1993, was cut (Välimaa 2004). The *second change* was the new University Act in 1997. It gave universities internal autonomy in all important matters and it also strengthened the quasi-market steering of universities as

well as the move towards defining specific performance targets for teachers and researchers. As stated, this has lead to the strengthening of the division of the academic staff to those having a permanent job and those having a temporary basis for their research work.

The graphs in Fig. 1 show the development of external financing. The extraordinary stage in 1991–1993 can be seen also: the real value of total operational expenditures was first fixed during 1991 and it then decreased during 1992 and 1993. The real value of external financing was growing during these years with the consequence that its share grew quickly from about 10 percent to about 30 percent. Towards the end of the period the share was slightly over 35 percent.

Figure 2 shows the shares of the main sources of external financing. The Academy of Finland financing (AF) represents the funding of traditional academic research and it makes financing decisions in field-specific research councils, which consist of university professors and Academy of Finland research officials. The purpose of Tekes (TF) is to finance research and development activities and it often presumes that there is at least one

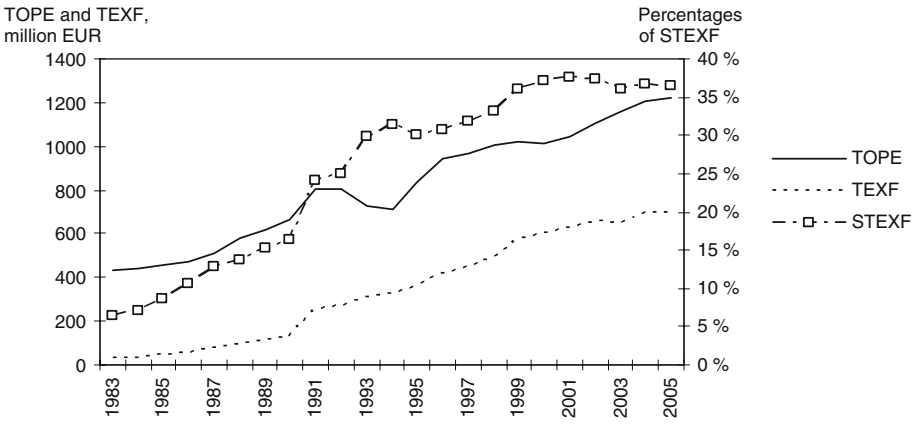

Fig. 1 Real total operational expenditures (TOPE), real total external financing (TEXF), and the share of the total external financing (STEXF) of the sum of total operational expenditures plus total external financing in 1983–2005

Fig. 2 Shares of the main sources of total external financing: Academy of Finland (AF), Tekes (TF), and industrial financing (IF)

firm as a partner in the projects it accepts. Domestic industrial financing (IF) consists of contract research with firms and research services to firms. It can be seen that although external financing of traditional academic research has the largest share, the financing of more applied kind of research (TF and IF together) has even a larger share.

All in all, the significance of external financing grew rapidly during the 1990s. The financing structure, however, did not change so as to favor the financing of applied research only. On the contrary, we can conclude that the financing of traditional academic research maintained its significance. The growth of total external financing implies, however, that universities, which were competing with each others to have good output in degrees and to have good changes in negotiating with the Ministry of Education on the amounts of budget money each will have, were forced to compete for external financing on the basis of their own strong areas. Although all universities continued to produce some mix of Master's degrees, doctorates, and research they were able to concentrate more on one or two types of outputs. In addition, they were able and encouraged also to provide consulting and developing services to industry companies. These features suggest that the clustering of the Finnish university system was to change between 1994 and 2005.

The decreasing productivity of universities in publishing and in producing Master's degrees and doctorates

Although the financing model and other regulative measures aimed at increasing the productivity of the key operations of universities, the growth of volumes has not been followed by the growth of productivity. This can be seen in Fig. 3 where the productivity of both publishing and in producing Master's degrees has been around one unit per one academic person. The lines are slightly decreasing rather than increasing—hence, the question of non-positive increase in productivity is justified. It is worth of noticing that the number of degrees per faculty teacher grew in the end of the 1990s to its present level where it has been for several years.

The problem of the productivity of publishing is noted also in a recent Finnish report on scientific publication in Finland (Poropudas et al. 2007). Actually, by using slightly different calculations the report concludes that the productivity has weakened. The report also discusses on the possible causes of the decrease. The three major causes are suggested to be

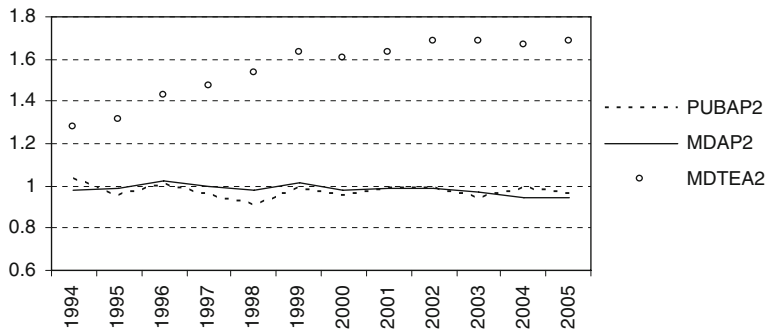

Fig. 3 Proxies of productivity in producing degrees (per academic person = MDAP2; per teacher = MDTEA2) and publications (PUBA2). Time lag between output and personnel is 2 years and a three year moving average is used

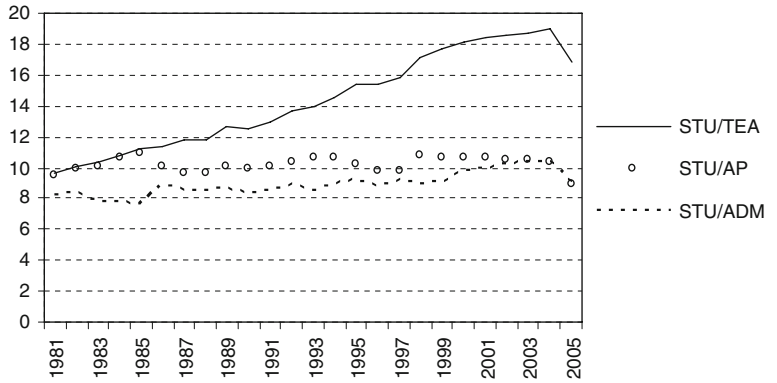

Fig. 4 The number of students per different personnel groups (TEA = faculty teachers; AP = academic personnel; ADM = administrative staff)

an *increase in overall teaching load*, the *shift of research activity* towards applied research and the *decreasing returns* of increasing research workers due to the employment of younger and non-experienced researchers. However, the results of two time use surveys of university staff done by the Statistics Finland concerning the academic years 1991–1992 and 2004–2005 show that the faculty teachers' allocation of time between research and teaching has remained roughly the same. On the basis of Fig. 4 we can, however, conclude that the number of students per faculty teachers has grown remarkably indicating probably some kind of congestion effect in the production of Master's degrees. This may also have a negative impact on the productivity of publishing in journals although it is impossible to show with the available data.[8]

The other two hypotheses (shift of research activity and decreasing returns) are further studied in "On the causes of the weakening of the research performance of Finnish universities" section. The shift in the activity from publishing in academic journals towards conducting more applied research is one consequence of the increase of the external money, especially TF and IF. The decreasing returns hypothesis needs some qualification in lines with the theory above. As Geuna (1999) suggested, the interplay of competing for external money and concentration of resources would give birth to a kind of Matthew effect in that those universities who have resources and talented researchers are able to recruit more talented research workers. This would mean that there should be a clear difference among various university clusters in research productivity and in the ability of extra researchers to produce extra publications.

University clusters in Finland

The above analyses of the overall development of Finnish universities underline the need to go deeper into the analysis of the available data. In this section we study the clustering of the Finnish university system in 1994–1995 and in 2004–2005. The clustering is based on

[8] Smeby (2003, p. 136) reports on a Norwegian data showing that the lack of uninterrupted time was the greatest problem of faculty members in a 2000 survey. That is, 57% of the respondents ($n = 1436$) reported that the lack of uninterrupted time caused many problems for their possibility for undertaking research.

Geuna's similar work on European universities and British universities.[9] This means, than in order to have a proper point of comparison, the same variables were entered in the clustering than in Geuna's analysis. The subsequent sections also shed light on some variables left outside in Geuna's analysis.

Clusters are here used as technical constructs in classifying the universities into different groups. The technique minimizes the within-group variance to find similarities, and it maximizes between-group variance to find dissimilarities. In this way the clustering helps us to see the general influences of the changes in the funding environment. It also connects available data to the theoretical notions presented above: different universities have reacted differently to the changes in their environment. Furthermore, clusters can be seen as manifestations of the evolving strategies of universities to use a mix of financing resources to produce a mix of outputs.

In the cluster analysis the critical variables were the share of external financing of total operational financing, publications per academic personnel, and the ratio of researchers to students. The clustering into three groups identified among universities two extreme groups and one middle-group between. The idea was to identify clusters of the most research oriented universities on one extreme and the least research oriented universities on the other extreme. Also the changeovers from one cluster to another between 1994–1995 and 2004–2005 were identified and further analyzed. Appendix 2, Tables A2.1 and A2.2 show the list of the Finnish science universities, their cluster membership as well as information on their resources and on their subject-mix in education.

Table 1 shows that the clusters differ according to the share of external research financing, publishing productivity, and research orientation. In time point 1994–1995 the first cluster consisted of universities having strong research orientation. The size of such a university was large and it had high productivity in publishing and in producing doctorates. A core member in this cluster is the University of Helsinki but other generalist universities are also good representatives. In the opposite end of the continuum is cluster three. The typical university there had a specialist orientation and a very weak research orientation. It was also small and had low productivity in publishing and in producing doctorates. Also the share of external financing was almost negligible. Small universities and business schools belong to this category. However, this cluster was productive in producing Master's degrees. Also the marginal productivity of academic labour force in publishing journal articles was higher than in cluster two for labour input increases between 1997 and 2002. Between these two clusters lies cluster two which is characterized by rather low productivity in publishing and in producing doctorates but a rather high research orientation in terms of academic persons per students. Helsinki University of Technology serves as a representative core actor in this cluster.

In the time point analyzed above, the overall share of external financing was small and no conclusions can be made except that cluster three got almost all its financial resources from the government. An interesting question, then, is the further development of the system. Can we see the effects of increasing external financing, the strengthening of competition in the allocation of external financing, and the overall change of the regulation of universities after the budgeting crisis in 1991–1993?

[9] Because the number of observations in the Finnish case is small ($n = 16$) we were not able to run the principal component analysis. Instead, a simple K-means analysis was conducted for descriptive classifying purposes. Therefore the study is not able to replicate Geuna's model but it assess, nevertheless, the Finnish case with the same key variables as Geuna's model (see Appendix 1 for the technical details of the clustering).

Table 1 Finnish university clusters in 1994–1995 and 2004–2005

	Cluster I		Cluster II		Cluster III		p[a]	
	1994–1995	2004–2005	1994–1995	2004–2005	1994–1995	2004–2005	1994–1995	2004–2005
Clustering variables								
Share of external research financing STEXF (%)	7	25	8	33	2	14	0.000	0.000
Publications per academic persons PUBAP	1.26	1.16	0.62	0.61	0.57	0.46	0.004	0.008
Academic persons per students APERSTU	0.09	0.08	0.08	0.10	0.06	0.06	0.007	0.007
Variables								
Academic persons APER (AVG)	1264	1399	692	937	247	267	0.003	0.002
Publications PUB (AVG)	1590	1624	433	569	141	124	0.000	0.000
Academy of Finland share of research financing AFSH (%)		35		16		28		0.038
Tekes share of research financing TFSH (%)		15		32		12		0.005
Industry share of research financing IFSH (%)		10		21		5		0.017
Master's degrees per academic persons MDPER	0.82	0.94	0.89	0.75	1.48	1.49	0.003	0.000
Doctorates per academic person DDPER	0.09	0.11	0.05	0.08	0.04	0.09	0.005	0.116
Marginal productivity in publishing MPPUB[b]		2.47		0.82		1.11		0.046

[a] Kruskal–Wallis test exact sig.

[b] Increase of publications from 2000 to 2005 per increase of academic persons from 1997 to 2002

The striking change between the time points of the comparison is the increasing share of external financing of total finance. The share increased in all groups cluster two having the highest share and cluster three the lowest one in 2004–2005. We can also notice the overall decrease in publishing productivity—the proportionally greatest decrease characterizes cluster three.

In 2004–2005 time point the clustering is based on similar features than in 1994–1995. Cluster one has a strong research orientation while the research orientation in cluster three has remained low in terms of publications per person and academic persons (researchers) per student. However, doctorates per academic person increased strongly in cluster three and the performance reached the same level as in the other two clusters.

In analyzing the Finnish system one should note the development of cluster two. It is characterized by (1) high share of external financing (2) external financing pattern strongly biased to R&D and industrial money, (3) strong growth in academic personnel, and (4) increased ratio of academic persons to students. These characteristics are associated, at the same time, to non-increasing productivity in publishing and in producing Master's degrees. Clearly, cluster two is oriented towards applied research where research may often involve many other activities than publishing in academic journals.

The clustering and the change between the time points seem to differ from that of UK in 1989–1994. The results found by Geuna are collected in Table 2.

Table 2 Clustering of British universities in 1990–1993 (Geuna 1999)

Variables	Cluster I		Cluster II		Cluster III	
	1993	1990	1993	1990	1993	1990
Academic personnel	1698	1206	836	479	478	346
Publications	2266	1001	667	350	293	173
Publications per academic person	1.33	0.82	0.84	0.75	0.60	0.82
Research financing share	33	23	20	16	14	13
Industrial financing share	8	11	9	15	24	20

Although the number of academic personnel and the publishing volumes between the three clusters differ in a similar pattern in UK and in Finland, it is the cluster three which receives the highest industrial financing share and which is the least productive in producing publications. In Finland these two features are divided between clusters two and three: cluster two has highest share of industrial financing and cluster three is the least productive producer of publications. The figures of UK universities suggest, according to Geuna (1999), that since the 'middle cluster' seems to weaken, the British university system is on its way to a polarization. One end of the continuum is occupied by research oriented universities and the other end by universities directed towards more applied kind of research and development. Geuna also sees some symptoms that the increased industrial financing would be connected to decreasing productivity in publishing.

Changes in cluster membership

Since there is the three cluster grouping both in 1994–1995 and in 2004–2005 and since the clusters differ in qualitatively same way in both time points, it is interesting to analyze the characteristics of the dynamics among the groups. Especially, it is interesting to see the differences between (1) universities who have strengthened their research orientation, (2) universities who strengthened their applied research orientation, and (3) universities who have remained roughly stable. The analysis has, however, strong reservations since there were only three universities in group one and two universities in group two.

Table 3 shows that the universities which have upgraded to cluster one had the highest share of Academy of Finland financing indicating strong orientation towards traditional academic research. Those universities which upgraded to cluster two had the highest shares of financing from Finnish Technology Agency and from industry companies.

The figures in Table 4 show that the group 'newcomers to cluster one' stands out regarding publishing and producing doctorates: publications per academic person and doctorates per academic person are high in 2004–2005 and especially the marginal productivity in publishing is very high. The group 'newcomers to cluster two', on the other hand, is distinguished

Table 3 Changing and stable cluster membership and financing structure in 2004–2005

	Newcomers to cluster one	Newcomers to cluster two	Stationary universities
STEXF (%)	25	27	20
AFSH (%)	32	15	29
TFSH (%)	13	26	18
IFSH (%)	11	19	9

Table 4 Changing and stable cluster membership and university output profiles

	Newcomers to cluster one	Newcomers to cluster two	Stationary universities
$PUBAP_{1994–1995}$	0.87	1.05	0.61
$PUBAP_{2004–2005}$	1.10	0.77	0.64
$MDPER_{1994–1995}$	0.98	0.82	1.23
$MDPER_{2004–2005}$	1.02	0.82	1.17
$DDPER_{1994–1995}$	0.06	0.06	0.06
$DDPER_{2004–2005}$	0.11	0.09	0.09
MPPUB	3.24	0.73	1.23

as regard to low productivity in publishing and in producing Master's degrees. Also here the larger share of external funding—especially in variables IFSH and TFSH—is associated to low productivity in publishing and low marginal publishing productivity.

Discussion

The above analysis creates an organized picture of the Finnish science university system between 1994 and 2005 and of the role of external financing in the development. Clearly, cluster one and three are directed towards different profiles having definite consistency with the traditional thinking of the role of university and the criteria of allocating public financing to universities. In brief, cluster one has clear academic research orientation whereas cluster three is more immersed in producing Master's degrees.

The profile of cluster two seems to be a bit problematic. It does not perform well in traditional functions of universities (in spite of producing doctorates in 2004–2005). However, it has grown rather strongly regarding academic personnel and it has increased very strongly its financing from both Finnish Technology Agency and from private companies. This cluster comes close to the archetype of a 'New University' characterized as aiming to applied or practice based research involving technology transfer task and having more numerous stakeholders than the traditional research university (see OECD 2005).

The findings of the analysis serve as a basis to answer to the research questions in "The change in the financing structure and its influence of the Finnish science universities" section. First, it can be argued that the Finnish university system has clustered into three groups according to the three key features, viz., publishing performance, scientific orientation (academic persons per students) and the share of external financing of overall operational expenditures. The same key variables cluster the university units in each time point (1994–1995 and 2004–2005) but there has occurred changes both in cluster memberships and in the magnitudes of the key variables. The examination of the universities which changed their cluster membership between the time points substantiate our main finding: *clusters are different and differences in the financing structure are associated with differences in the outcome profiles of the clusters*. Although each cluster has its own profile (traditional academic research, R&D activities, and education) corresponding with the expectations of the higher education policy Finland, there are problems related to the performance of the university system as a whole. Especially, there is a signal of the weakening of the productivity of research. This is discussed in "On the causes of the weakening of the research performance of Finnish universities" section.

Second, the clusters differ in research performance measured in terms of scientific publications. Although the differentiation has not unambiguously enlarged in terms of

publications per academic persons (except that cluster three has weakened its performance more than the other two clusters), there are signs of clear differences between the clusters in the marginal productivity of academic labour concerning the production of publications. Thus, academic personnel have increased the amount of publications most successfully in cluster one in 2000–2005. It is also worth of noticing that cluster three outperforms cluster two in this respect. Obviously, the explanation is that because cluster two is oriented to applied research and R&D activities, the extra research inputs produce other outputs than scientific publications. This, of course, can be a problem if government financing is partly tied to publishing activity—doing other research activities than publishing forces researchers to reassure financing bodies by other means than publishing. This may lead to the weakening of the quality of scientific knowledge and the growth of scientific knowledge base. The differences and changes in marginal productivity are discussed below.

Third, the analysis of the changing cluster memberships shows, at least tentatively, that some universities adopted very successfully the profiling towards the traditional academic research university ideal. In other words, they succeeded in getting finance from the Academy of Finland and lift up the number of scientific publications per academic personnel. These universities were also successful in hiring additional academic labour force: the marginal productivity of extra labour (in producing scientific publications) was high in 2000–2005 (see Table 4).

This development of the Finnish university system has several common features with the development in other European countries. The analysis above found some parallels with the observations made by other researchers concerning the impacts of competitive funding on national university systems. Especially, it seems that some universities adapt to the changes in the funding structure by maintaining their performance level in producing outputs (see Liefner 2003) while others are more responsive and use the changes in the funding structure in strengthening their output profile (see Bonaccorsi and Daraio 2008). Furthermore, this study identified also the weakening of the research performance referred to in several related analyses. Concerning the allocation of working hours to research and teaching, it was remarked, that in a line with several international observations (see Smeby 2003), the time allocation at the aggregate level in Finnish universities has remained roughly the same between 1991 and 2004. But, as will be commented in the next section, there were variations between individual universities and between the groups of universities.

Regarding the research design of this study, we are able to make comparisons to Geuna's (1999) comparable studies on European universities and UK universities. It seems that while Geuna finds signs of the polarization of universities (in European data and in UK data) to small low research universities on the one hand and large research-intensive universities on the other hand, the Finnish data speaks more like a tripartite process.[10] That is, there is some evidence to argue that the Finnish science university system comprise of three different clusters each cluster specialized mainly but not exclusively in one of their three basic functions—viz. basic research, applied research, and education. However, in the same way as Geuna's analysis, also our analysis shows that the change in the financing structure of universities has influenced on the development of universities. Especially, the universities which get a large portion of their financing from industry and/or financing councils dedicated to the promotion of R&D activities, have a low research output and research productivity measured in scientific publications. The reverse side of this is the fact that the research-intensive universities, consisting of pre-war universities and of some new

[10] See also the analysis of Australia's university clustering by Valadkhani and Worthington (2005).

institutions, have preserved their status as research-intensive universities even though their overall research performance also weakened between 1994 and 2005.

Finally, some remarks can be made on the recent trend in the Finnish university policy which encourages universities to merge or launch quite formal collaboration. Actually, based on the negotiations between the Ministry of Education and the universities in autumn 2007, two new universities are to be created through merging. Interestingly, these mergers can be seen, in our framework, as attempts to utilize the strategic possibilities in cluster one and two. Namely, one new university is constructed by uniting two middle-size universities—one occupying a 'fringe area' in cluster two (the University of Kuopio) and the other standing in the 'edge' of cluster three (the University of Joensuu). The new university (the University of Eastern Finland) will be a strong generalist university and occupy its place in cluster one. The other new university (Aalto University) will be created through a merger of the 'core actor' universities in cluster two (Helsinki University of Technology) and three (Helsinki School of Economics) plus one institution outside the group of science universities (the University of Art and Design Helsinki). This new university will connect the increasing level of industrial funding to applied research and education and it serves industry and employers and puts priority to international collaboration and competition. In addition to these cases there are plans of formal collaboration between several other universities. In consequence, the division of labour between Finnish universities will be further strengthened in the future. The critical factor here is related to cost savings which are expected to come from the concentration of resources and the reduction of diversity and from demolishing duplicate study programs and other operations. The problem here is that although these measures may cut fixed costs, they may become outweighed by larger losses the majority of which will be fallen on university students (see Kelchtermans and Verboven 2008, who analyse the possible consequences of similar policy initiatives in Flanders, Belgium). This problem poses a challenge to higher education researchers, policymakers and universities since decentralized incentive mechanisms coupled with aims of reducing costs may, as Kelchtermans and Verboven (ibid.) state, result in outcomes that are undesirable from a total welfare perspective.

On the causes of the weakening of the research performance of Finnish universities

A major finding of this research is the weakening of the research performance of Finnish universities between 1994 and 2005. The same fact is also documented in Poropudas et al. (2007). They also provide five hypotheses of the factors having a probable negative influence to research productivity. Three of these hypotheses are relevant to our analysis[11]:

(1) *The increasing teaching load due to the more rapid growth of the number of students compared to the number of teaching staff*. Contrary to this hypothesis, the authors note that according to the Statistics Finland study the allocation of weekly working hours to research decreased, when measured in percentages, only from 40% to 39% between years 1991 and 2004. The authors ignore, however, the fact that there were large differences between universities. The largest decrease was 14 percentage units and the largest increase was 6.3 percentage units. The clustering of universities gives

[11] The remaining two are (4) the establishing of the Finnish research school system in the late 1990s and the use of (5) research personnel inputs to teaching.

some, albeit restricted, evidence contrary to the argument by Poropudas et al. Namely, the decrease of working hours allocated to research is strongest in cluster three (from 37.3% to 31.3%) but occurred also in cluster one (from 39.7% to 37.4%). At the same time the proportion increased in cluster two (from 38.8% to 40.8%). This means that in 2004 the faculty teaching staff devoted more weekly ours to research in cluster two than in the other two clusters. This does not correspond per se with the different orientations of the clusters but it nevertheless undermines the argument by Poropudas et al. What is clear is that this needs a more detailed analysis.

(2) *University research has evolved towards applied research*. This means, according to Poropudas et al. (2007) that the striving towards research that is applied and produces innovations to practical uses has lead to the fact that the increase of academic personnel does not cause the increase of scientific publications. Instead, more research inputs are employed in collaboration with firms and the outcomes are commercial applications and patents rather than journal publications. The analysis based on clustering the universities corresponds with this hypothesis. This means that cluster two, which has increased its academic personnel very strongly without an increase in scientific publications, has obviously made its output in terms of collaboration, commercial applications and patents. This, of course, only increases the reasonability of the hypothesis which still needs empirical appraisal.

(3) *Marginal productivity of research inputs*. Here the authors refer to discussions that the decrease in research productivity would have resulted from the diminishing marginal productivity which 'steps in', by definition, after the increase of inputs exceeds certain limit. In particular, the authors refer to the fact that when research activity has expanded, the universities have not been able to employ as productive workers as before. This, again, needs a more profound analysis since diminishing productivity may result also from other sources than workers' individual productivity, namely from difficulties in organizing research work/teams, the displacement of productivity when research organizations become too large and so on. The analysis in this paper gives some light to this discussion (and to the elaboration of the hypothesis). That is to say, the marginal research productivity measured with a proxy variable MPPUB (Tables 1, 4) was in 2000–2005 higher in cluster one (the research orientated group) than in clusters two and three, and it was extremely high among the newcomers to cluster one. Correspondingly, marginal research productivity was very low in cluster two and among the newcomers to cluster two. Both of them are characterized by the high share of financing from companies and Finnish Technology Agency implying the orientation towards applied research and R&D activities which cannot be measured with the data available to this study. This means, in other words, that part of the explanation of the weakening of the research performance would lie in the changes in the operational environment of the universities—for example, such things as competitive financing and increasing demands of applicable outcomes. This does not rule out the diminishing marginal productivity hypothesis but emphasizes the elaboration of the research setting for studying the question.

Conclusions

In Finland the present higher education policy and research policy combines certain de-regulative and service-based financing measures. These measures amount to (i) giving more autonomy to universities, (ii) increasing the role of competitive financing, and (iii)

emphasizing the financing of specific services rather than general operative functions. The crucial question here is the following: have these changes produced negative unintended consequences in addition to, or in spite of, the intended positive outcomes?

It can be argued that the intended outcome is the more clear division of Finnish universities to various groupings. In this new division each university emphasizes (but not exclusively) either (i) traditional academic research, (ii) applied research and R&D activities, or (iii) education functions. The unintended consequence is the impoverishment of the research performance in terms of scientific publishing. Although this is partly displaced by the probable (but not here empirically corroborated) fact that some applied research and R&D activities give positive inputs to the surrounding business and other economic life, there remains the thread of the lowering quality of knowledge produced. More exactly, this development may threaten the basic research and the functions it has in knowledge production. In short, some knowledge may not become 'discovered' if research aims to short-term results only and if more risky projects are not financed. Also, if knowledge does not develop through the self-correcting process in the process of scientific knowledge production, but is applied 'immediately after the discovery', then uncertain or even false knowledge is transferred from universities to firms and other users of it.

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Appendix 1: The clustering of Finnish science universities

The clustering of Finnish science universities ($n = 16$) was based on *K*-means clustering which is a multivariate statistical technique that uses the following Euclidean distance as a dissimilarity measure (used in minimizing the total intra-cluster variance):

$$D(a,b) = \sum_{i=1}^{n=3} (X_{ia} - X_{ib})^2,$$

where X_{ia} and X_{ib} are values of universities a and b in variable I, respectively. Thus, the smaller is $D(a, b)$ the more similar are the universities a and b.

The clustering partitioned Finnish science universities into three clusters on the basis of three variables (publications per academic person, researchers per student, and share of

Table A1.1 Final cluster centers 1994–1995

Z-scores	Cluster one	Cluster two	Cluster three
Share of external financing	0.91245	0.41382	–0.91245
Publications per person	1.28517	–0.08380	–0.67453
Researchers per student	0.91245	0.41382	–0.81699

Table A1.2 Final cluster centers 2004–2005

Z-scores	Cluster one	Cluster two	Cluster three
Share of external financing	0.26720	1.18237	–1.05545
Publications per person	0.93867	–0.28964	–0.74557
Researchers per student	0.15139	1.05831	–0.85693

Appendix 2

Table A2.1 Universities, clusters and main subjects offered

University	Cluster in 1994–1995	Main subjects in 1995, descending order of size (undergrad. students)	Cluster in 2004–2005	Main subjects in 2005, descending order of size (undergrad. students)
University of Helsinki	1	Hum, Nat, Soc, Agr, Edu, Law, The, Med, Psy, Vet, Hea, Pha, Den	1	Hum, Nat, Soc, Agr, Edu, Law, The, Med, Psy, Vet, Pha, Den
University of Oulu	1	Eng, Nat, Hum, Edu, Med, Bus, Hea, Den	1	Eng, Nat, Hum, Edu, Bus, Med Hea, Den
University of Turku	1	Hum, Nat, Edu, Soc, Law, Med, Hea, Psy, Den	1	Hum, Nat, Soc, Edu, Med, Law, Eng, Hea, Psy, Den
University of Tampere	3	Soc, Hum, Bus, Nat, Edu, Med, Hea, Psy	1	So, Hum, Nat, Bus, Edu, Med, Hea, Psy
Helsinki University of Technology	2	Eng	2	Eng
University of Jyväskylä	2	Hum, Nat, Edu, Bus, Soc, Spo, Psy, Hea	1	Hum, Nat, Bus, Edu, Soc, Spo, Hea, Psy
Tampere University of Technology	2	Eng	2	Eng
University of Joensuu	2	Edu, Hum, Nat, Soc, Agr, Psy, The	3	Hum, Edu, Nat, Soc, The, Agr, Bus, Psy
Åbo Academi University	2	Hum, Soc, Nat, Edu, Bus, Eng, The, Hea, Psy, Pha	1	Hum, Soc, Nat, Edu, Bus, Eng, The, Hea, Psy, Pha, Law
Lappeenranta University of Technology	3	Eng	2	Eng
University of Vaasa	3	Bus, Hum, Soc, Eng	3	Bus, Hum, Soc, Eng
University of Kuopio	1	Nat, Med, Hea, Soc, Pha, Den	2	Nat, Med, Hea, Soc, Bus, Pha, Eng
Helsinki School of Economics	3	Bus	3	Bus
University of Lapland	3	Soc, Law, Edu	3	Soc, Law, Edu, Bus
Swedish School of Economics and Business Administration	3	Bus	3	Bus
Turku School of Economics	3	Bus	3	Bus

Data source: KOTA data service, Ministry of education

Key to subject abbreviations: Hum = Human, Nat = Natural, Soc = Social, Agr = Agriculture and forestry, Edu = Education, Law = Law, The = Theology, Med = Medicine, Psy = Psychology, Vet = Veterinary, Hea = Health, Pha = Pharmacy, Den = Dentistry, Eng = Engineering, Bus = Business Economics, Spo = Sport

Table A2.2 Some resource indicators of Finnish universities in 2005

University	Undergrad. students	Teachers	Researchers	Academic staff	Costs per academic person	Costs per undergrad. student	External financing per academic person	Sq. m. per undergrad. student
Univ. of Helsinki	26,377	1544	1170	2714	160.3	16.5	37.7	12.5
Univ. of Oulu	11,615	770	474	1244	130.0	13.9	31.3	12.7
Univ. of Turku	11,301	769	386	1155	132.1	13.5	30.5	9.2
Univ. of Tampere	11,090	531	355	886	127.1	10.2	38.4	5.4
Helsinki Univ. of Tech.	10,676	423	1115	1538	134.4	19.4	52.1	13.7
Univ. of Jyväskylä	10,482	626	329	955	121.2	11.0	32.1	6.9
Tampere Univ. of Tech.	9032	334	674	1008	112.5	12.6	41.8	6.6
Univ. of Joensuu	5899	389	149	538	129.2	11.8	24.6	9.0
Åbo Academi	4755	325	237	562	125.6	14.8	35.0	12.4
Lappeenranta Univ. of Tech.	4502	175	295	470	109.4	11.4	36.1	6.4
Univ. of Vaasa	4070	156	35	191	126.3	5.9	15.2	2.4
Univ. of Kuopio	3948	322	292	614	109.1	17.0	41.9	8.7
Helsinki Sc. of Econ.	3157	157	73	230	156.4	11.4	48.4	3.0
Univ. of Lapland	2749	137	28	165	143.6	8.6	19.2	1.7
Swedish Sc. of Econ.	1912	100	17	117	133.1	8.1	23.8	7.8
Turku Sc. of Econ.	1681	113	74	187	114.2	12.7	33.3	9.2
Mean	7702.9	429.4	356.4	785.9	129.0	12.4	33.9	8.0
Std dev.	5975.3	359.1	345.1	652.5	14.5	3.3	9.7	3.6
Median	5937.1	346.6	312.0	633.3	128.1	12.1	33.6	7.9

Data source: KOTA data service, Ministry of Education. Money indicators in 1000 euros

external research financing). The variables measure the means of 2 years values in 1994–1995 and in 2004–2005. The clustering variables were transformed into *Z*-score variables.

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