

**EUROSTAT**  
**Task force meeting on Euro university statistics**

**Luxembourg, June 7-8, 2007**

**Census microdata on European  
universities**  
**The Aquameth project**

Andrea Bonaccorsi, University of Pisa

[a.bonaccorsi@gmail.com](mailto:a.bonaccorsi@gmail.com)

## Methodological choices. Microdata and new econometric techniques

Literature in higher education and university reform:

- institutional
- comparative
- mainly qualitative and descriptive.

Main limits to a quantitative approach:

- lack of microdata (OECD and Eurostat data refer to HE as an aggregate; issues of statistical secrecy)
- standard econometric techniques fail to capture institutional heterogeneity

Research directions:

- build large dataset based on microdata on universities
- use recently developed robust nonparametric techniques

# Theory

## A. University production

- University activity is **multi-dimensional**. Weighting dimensions in order to obtain a unique metrics (e.g. ranking) is not value-free
- Dimensions of activity of universities (teaching, research, third mission) are subject to positive **complementarity** relations but also to **substitution** effects (trade-offs)
- Causal assumptions problematic
- No production function approach

# Theory

## B. Research activity

- Research is subject to **strong positive feedback** mechanisms (Matthew effect, cumulative reputational effects, *winner-takes-all*)
- Distributions of research performance are highly skewed (Lotka's law)
- Relation between resources and performance only stochastic
- Dilemma between **picking the winner** and **spreading resources** for nurturing future capabilities (and promoting diversity)

# Theory

## C. Governance

- Universities are multidivisional organizations, that may transfer resources internally (e.g. from student fees to research)
- However, the governance of universities (in Europe) **is not dual**: university administrators do not have the power to support a strategy on recruitment unless academic bodies agree
- Conventions for academic quality are **unstable**
- Consequently, European universities (with a few exceptions) are collections of departments whose **scientific quality is poorly correlated**
- **No strategic management**

The challenge of the project was to demonstrate the feasibility of microdata on universities:

- (a) obtained from administration (Ministry of Research/ Higher Education, Ministry of Finance) and national institutions (e.g. Conference of Rectors)  
*(administrative data)*
- (b) on all universities in a country (*census data*)
- (c) comparable across countries (*comparability*).

No survey-based data

But also no official statistical validation

# Aquameth project



## **Aquameth 1 (2004-2006)**

- University of Pisa, **Italy** (A.Bonaccorsi, C.Daraio)- coordinator
- INGENIO, **Spain** (Adela Garcia Aracil)
- SPRU, **United Kingdom** (Gustavo Crespi, Aldo Geuna)
- CIPES, **Portugal** (Pedro Teixeira, Margarida Cardoso, Cláudia Sarrico, Maria João Rosa)
- UNISI, **Switzerland** (Benedetto Lepori)
- NIFU-STEP, **Norway** (Stig Slipersaeter)

## **Aquameth 2 (2006-2007)**

- CHEPS, **Netherlands** (Ben Jongbloed)
- IKU, **Hungary** (Annamaria Inzelt, Gabor Csizmazia)
- BETA, **France** (Mirelle Matt, Laurent Bach, Patrick Llerena)

## **Aquameth consolidation (2007)**

- University of Dresden, **Germany**
- VTTA, **Finland**
- University of Camberra, **Australia**
- Georgia Tech, Atlanta, **Georgia, USA**

## Aquameth project

Data on 271 individual universities from UK, Spain, Italy, Portugal, Switzerland, Norway

Census data

Administrative sources

Integration of Netherlands and Hungary data under way (March 2007)+ France (end 2007)

Integration of Germany and Finland (June 2007)

Time series 1995-2003

Data on inputs (academic staff, nonacademic staff, funding by type) and outputs (undergraduate students, postgraduate students, publications, patents)

Country reports on the evolution of HE system and policy.

# AQUAMETH Database

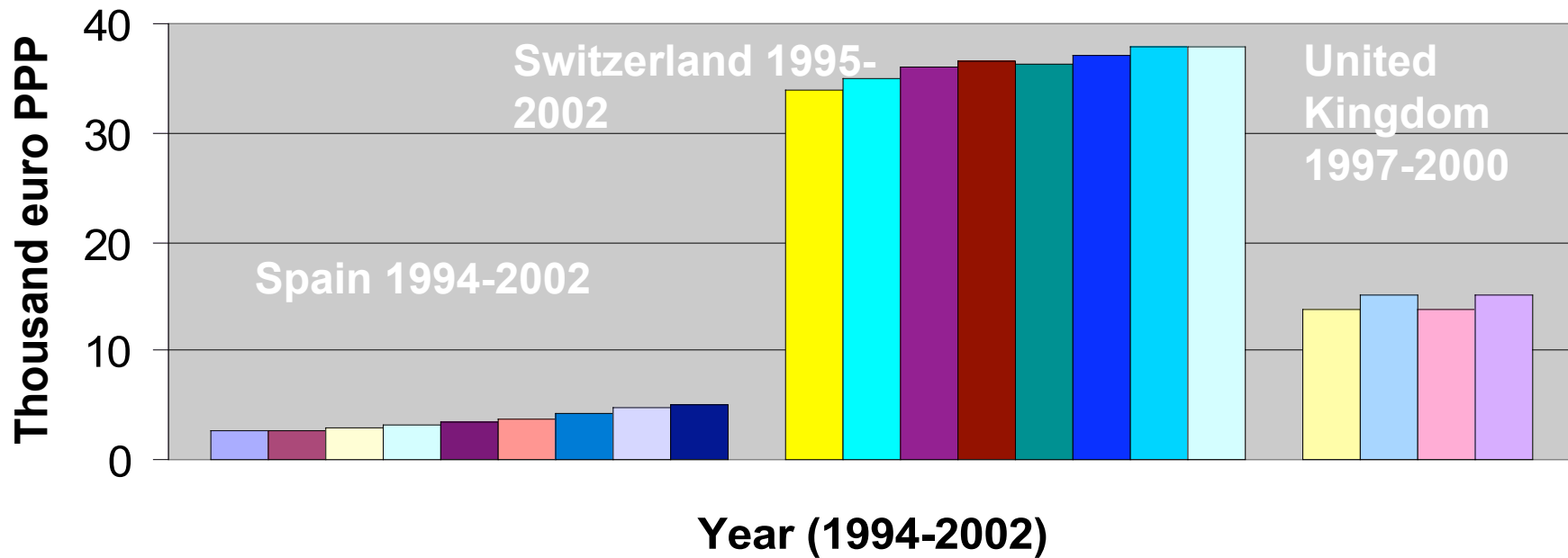
<b>AREA</b>	<b>CATEGORIES</b>
<i>General information</i>	<ul style="list-style-type: none"><li>• year of foundation</li><li>• city, province, region (NUTS)</li><li>• number and type of faculties/schools/disciplines covered</li><li>• governance (public, private)</li><li>• type (university, technical college)</li><li>• other relevant historical information.</li></ul>
<i>Revenues</i>	<ul style="list-style-type: none"><li>• Total revenues of the university.</li><li>• General budget of the university (in federal countries divided between national and regional appropriations).</li><li>• Tuition and Fees.</li><li>• Grants and contracts, if possible divided between government, international, private and private non-profit.</li><li>• Other revenues.</li></ul>
<i>Expenditures</i>	<ul style="list-style-type: none"><li>• Total expenditures (excluding investments and capital costs).</li><li>• Personnel expenditures, if possible divided between personnel categories.</li><li>• Other expenditures.</li></ul>
<i>Personnel</i>	<ul style="list-style-type: none"><li>• Total staff (FTE or headcount).</li><li>• Professors.</li><li>• Other academic staff.</li><li>• Technical and administrative staff.</li></ul>
<i>Education production</i>	<ul style="list-style-type: none"><li>• Number of undergraduate students.</li><li>• Number of undergraduate degrees.</li><li>• Number of PhD students.</li><li>• Number of PhD degrees.</li></ul>
<i>Research and technology production</i>	<ul style="list-style-type: none"><li>• ISI publications.</li><li>• Technological production indicators.</li></ul>

# Comparability issues

Three main categories of comparability problems:

1. Differences in the organization and governance structure of national HE systems (**institutional context**)
  1. Dual systems
  2. Private vs. public universities (some European countries have an HES which includes universities and a range of non-phd awarding institutions) - separate analysis
  3. Definition of private funding
  4. Part time students
  
2. **Heterogeneity of the individual HEI subject mix**
  - In AQUAMETH we focus on four broad disciplinary areas: Human and Social Sciences, Technical Sciences, Natural Sciences and Medicine
  - Possible solutions: dummy variable, operational categorization: generalist vs. specialist (see illustration)
  
3. **Data problems**

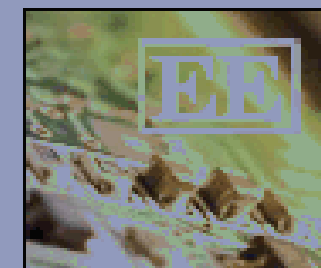
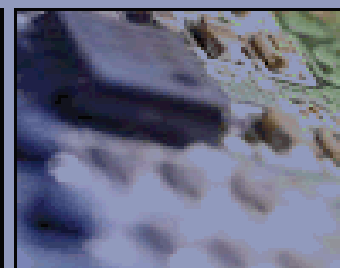
# Average expenditure per university student at purchasing power parity



**NEW TITLE FROM EDWARD ELGAR PUBLISHING!**

## Universities and Strategic Knowledge Creation

Specialisation and Performance in Europe



Edited by **Andrea Bonaccorsi**, University of Pisa, Italy and **Chiara Dario**, Istituto di Informatica e Telematica (IIT), Italy

Although the role of universities in the knowledge society is increasingly significant, there remains a severe lack of systematic quantitative evidence at the micro-level, with virtually all policy discussion based on country level statistics or case studies. This book redresses the balance by examining original data from universities in six European countries – Italy, Norway, Portugal, Spain, Switzerland and the UK. It provides micro-based evidence on the evolution of the strategic profile of universities in terms of scientific research, contract research, education and the third mission. The result is a highly innovative book that combines detailed national case studies and comparative institutional analyses with state-of-the-art quantitative techniques.

Contributors include:

M. Benninghoff, R. Bogazzi, A. Bonaccorsi, M.R. Cardoso, G. Crespi, C. Dario, M. Filippini, H.O. Fried, A. Garcia-Azari, M. Gulbrandsen, M. João Rosa, B. Jongbloed, B. Lepori, C. Salento, C.S. Santos, L. Simat, S. Slipersacker, R. Teixeira, R. Vanden Brouck

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May 2007, c. 256 pp., Hardback: 1 84720 110 5 / 978 1 84720 110 2, c. \$55.00

PRIME Series on Research and Innovation Policy in Europe

## What can be done

- Indicators building
  - expenditure per student
  - PhD intensity
  - publication intensity
  - share of private funding
  - normalized shares of funding
- Positioning of individual universities
- Efficiency analysis
- Conditional efficiency analysis

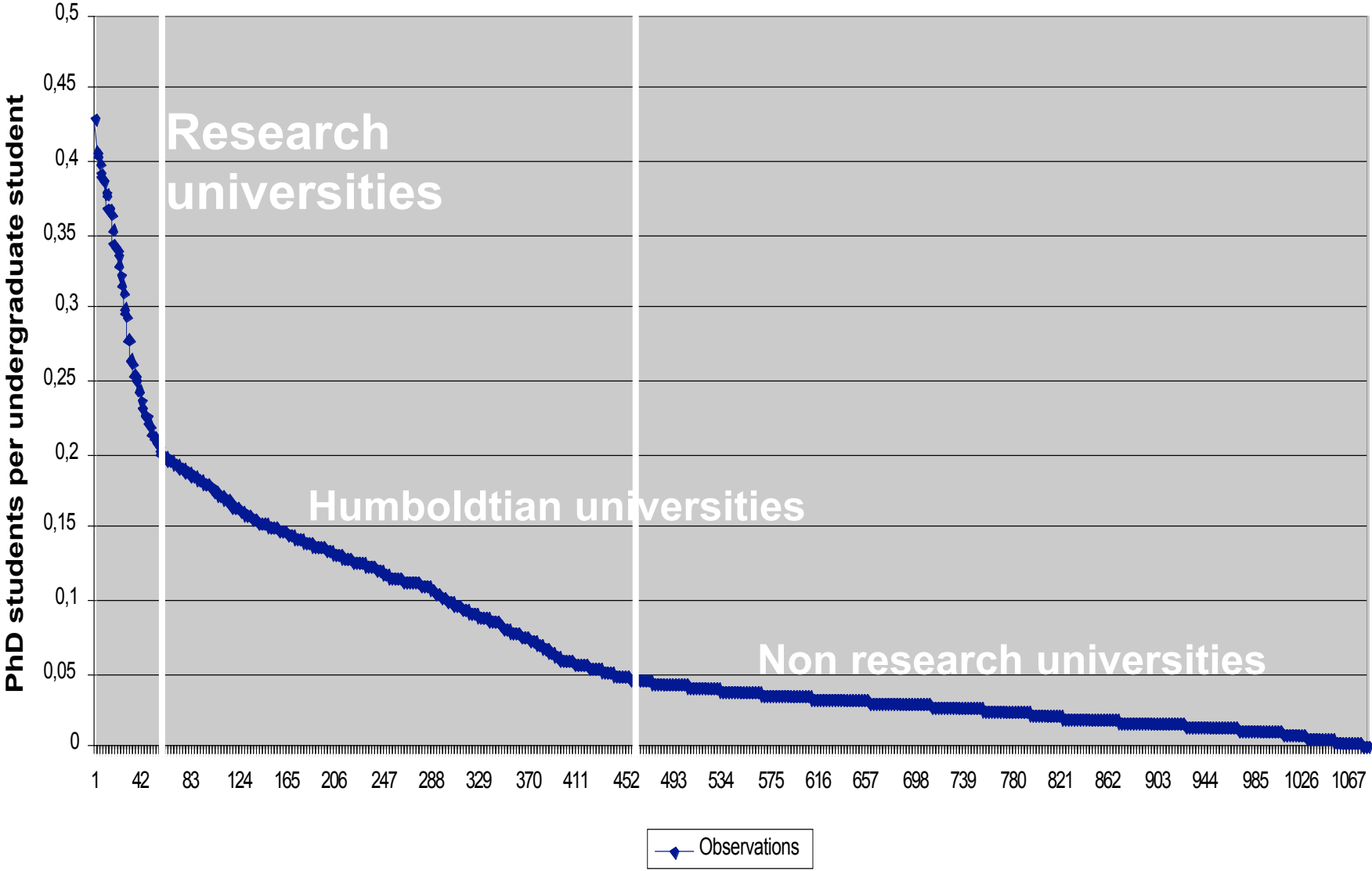
## Stylized facts on European universities

1. Lack of differentiation in funding structure
2. Lack of institutional differentiation in the output profile
3. Trade-off between research and teaching

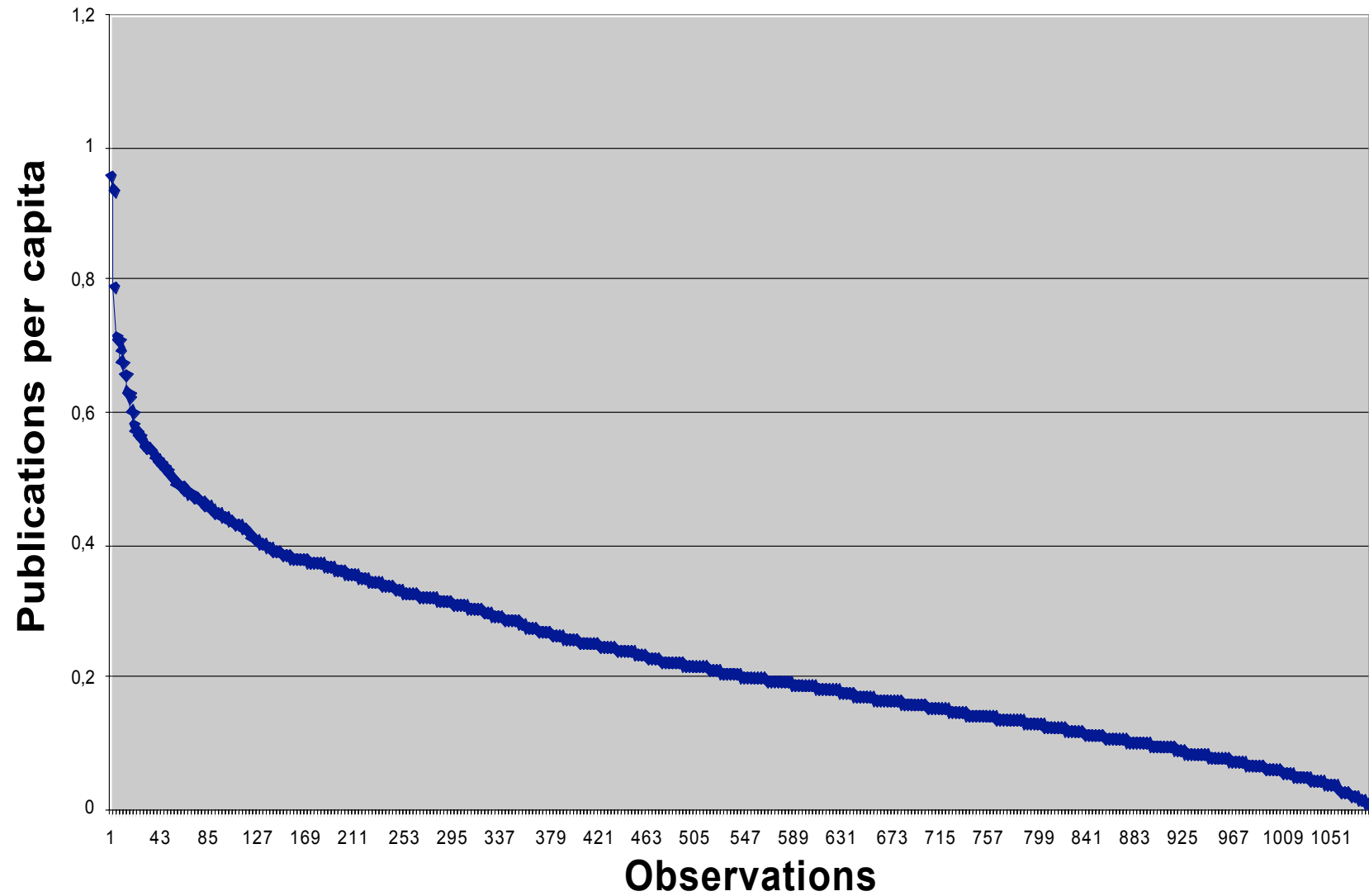
In reforming universities, governments should not aim to restrain their degrees of freedom, but rather promote and support the **differentiation of universities**, giving full content to the notion of autonomy.

Universities should be encouraged to adopt a **strategy**, that is, a consistent plan of action that makes the best possible use of resources (current and planned) in building a **long term profile in the output mix**.

# PhD intensity (Number of PhD students/ Number of undergraduate students)

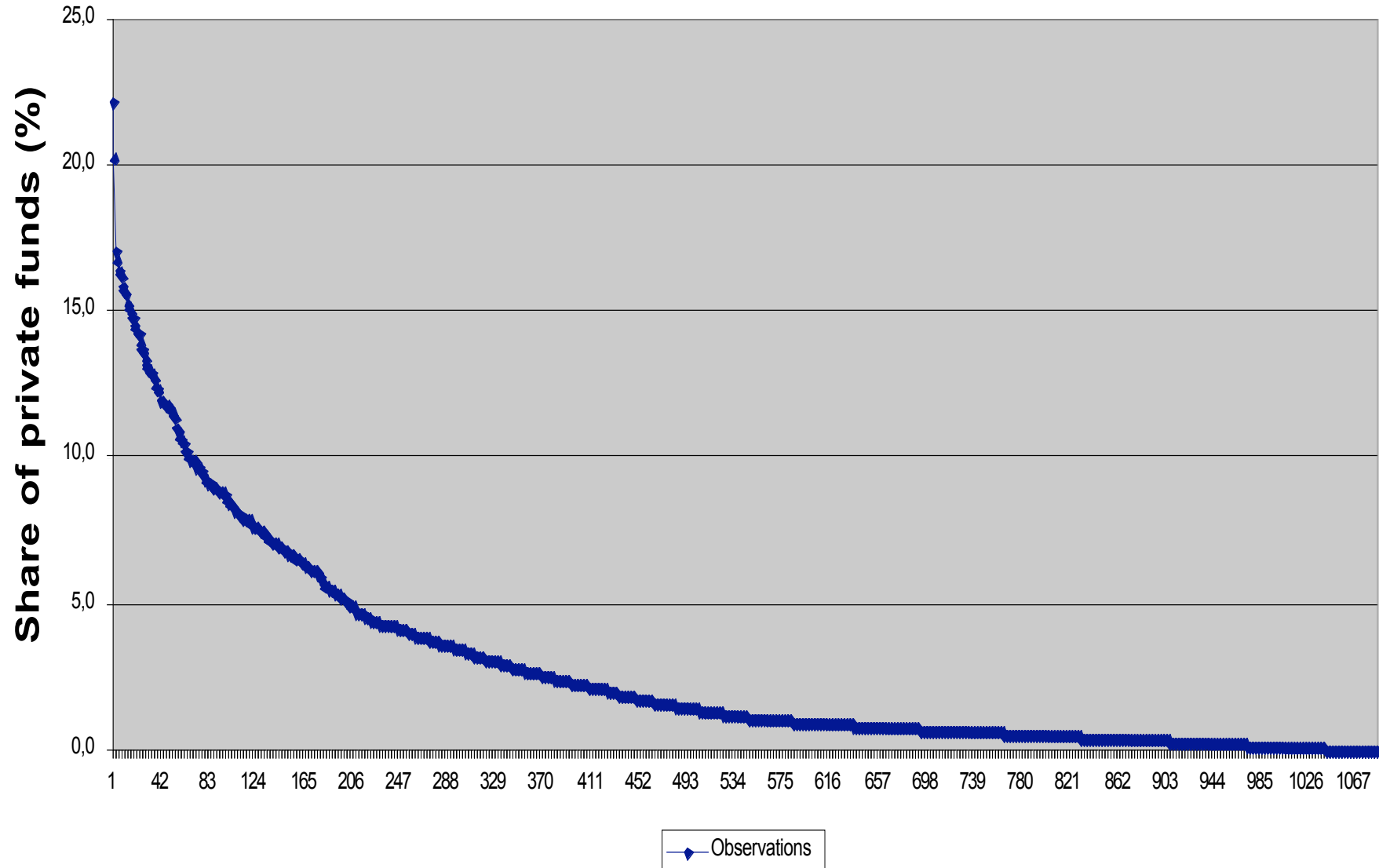


## Publication intensity (international publications per unit of academic staff)

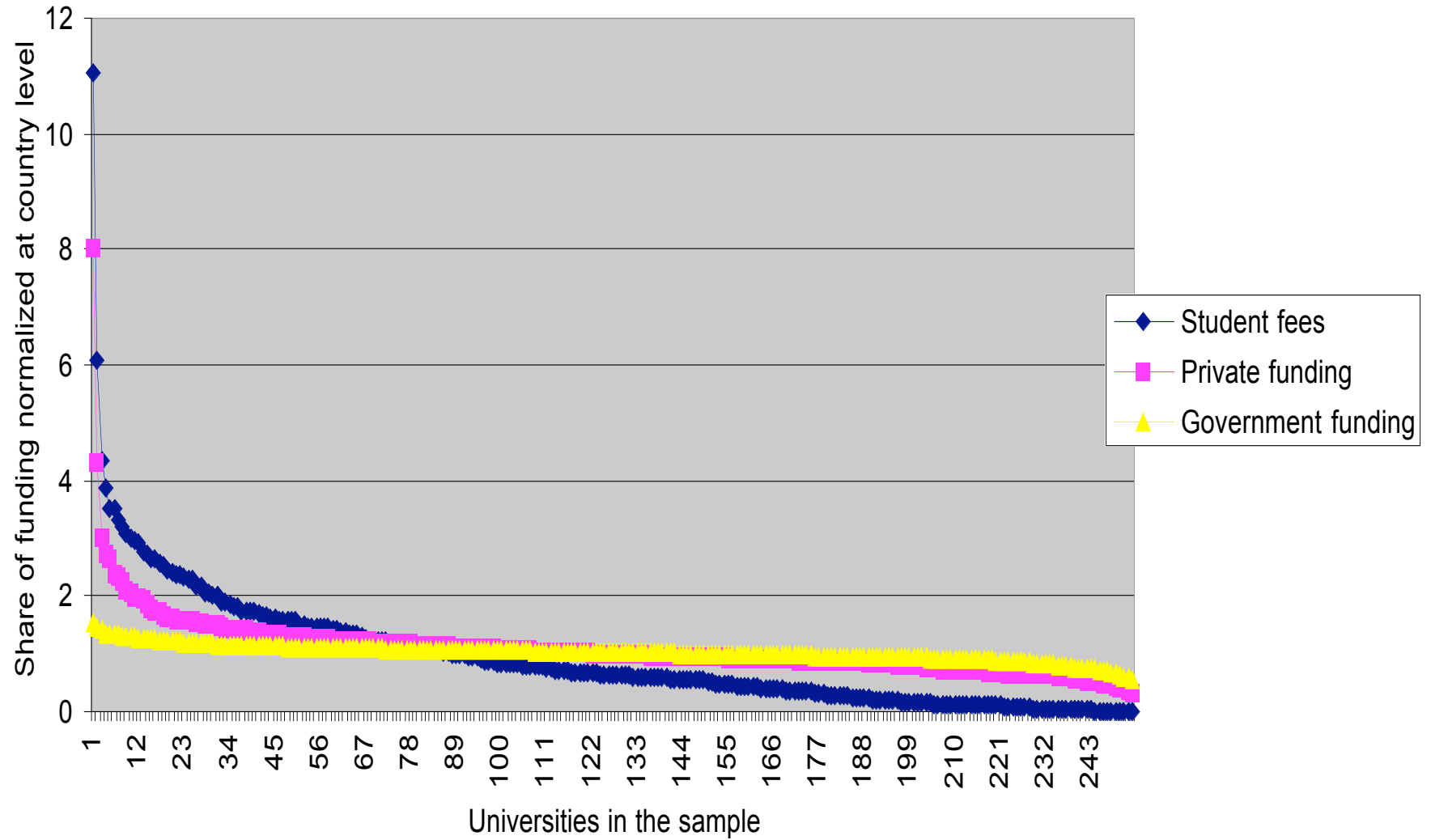


# Private share of funding

(private contracts and donations as a % of university budget)



## Variability of sources of funding across universities



# Autonomy

Granted by legislative reform in most European countries in 1980s and 1990s. Areas covered by autonomy:

- budget
- personnel expenses.

Constraints:

- **selection of academic staff still decided within academia;** university strategy weak with respect to self-promotion strategies of academia (e.g. weak role of President in European universities);
- large part of university budget allocated to personnel expenses; **parameters of cost of academic staff not decentralized** (status of public official);
- **limited manoeuvring with non-governmental financial sources** (student fees, private funding including donations, EU research)- but great dynamism here.

## Positioning indicators

- Ranking is legitimate with respect to relatively homogeneous units (e.g. departments)
- Top ranking in research depends crucially on the window of observation
- Ranking on top research is likely to overrate large generalist universities and underrate specialist universities and small specialized research areas
- Positioning indicators try to build up a multidimensional representation of university performance, without any assumption on weights and coefficients of substitution

Simulation exercise on complete dataset (comparable data, no missing values, time series available, number of observations n= 1084)

## **Model of university production**

### A. Teaching

- Total expenses per undergraduate student (€)
- Number of academic staff per undergraduate student
- (Number of curricula per undergraduate student)

### B. Research

- Number of PhD student per undergraduate student
- Number of international publications per unit of academic staff

### C. Third mission

- Share of private funding (contracts, donations) on total university funds

**Comparability issues.** Normalization of data

## Individual profile of universities

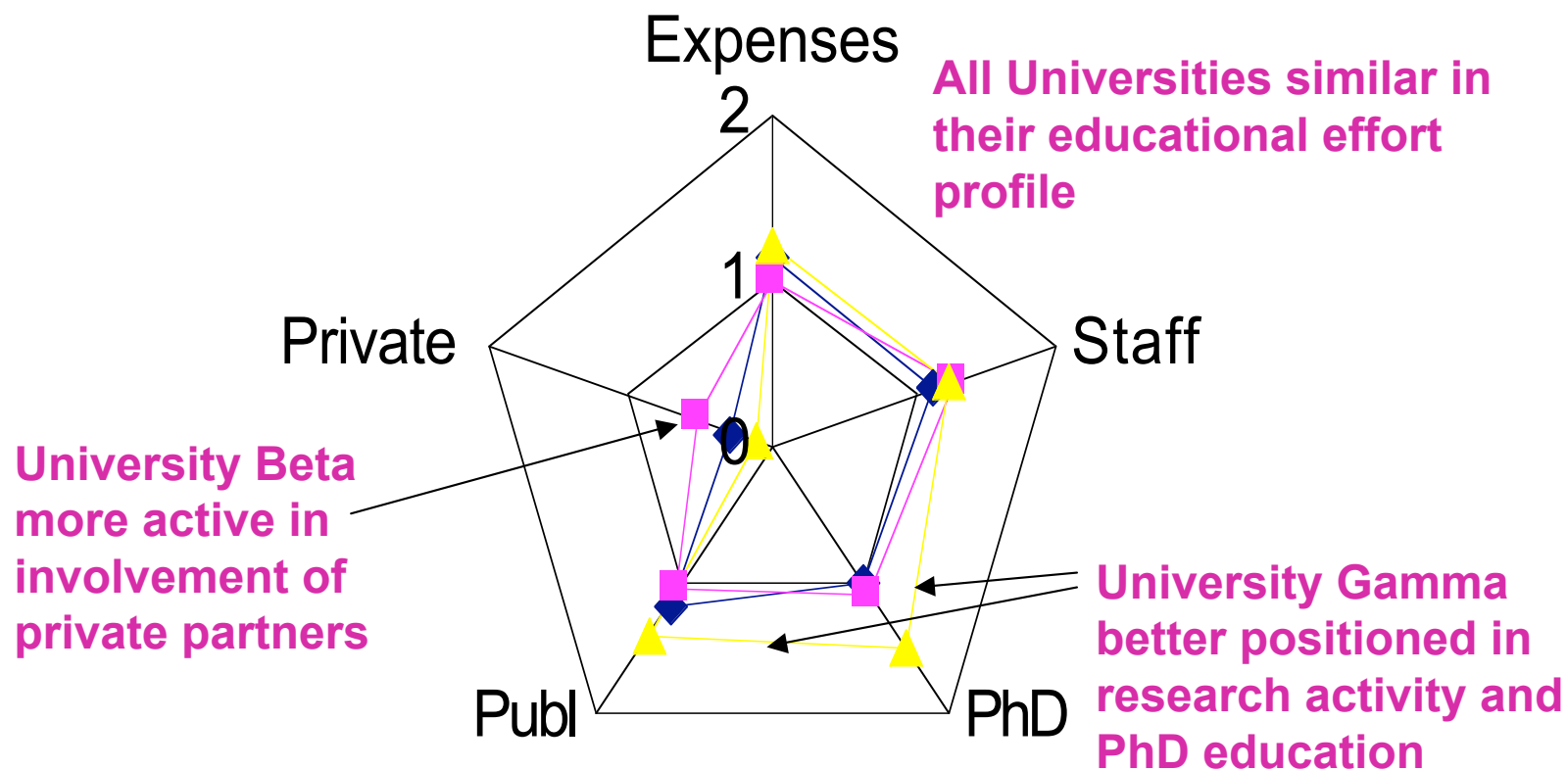
### Simple **radar representation**

- Comparison with other universities in the same country
- Detection of changes over time
- Positioning in international comparisons

This simulation- compact and simple production model.

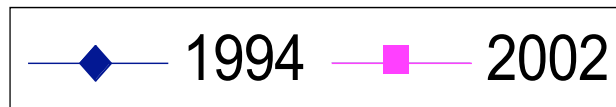
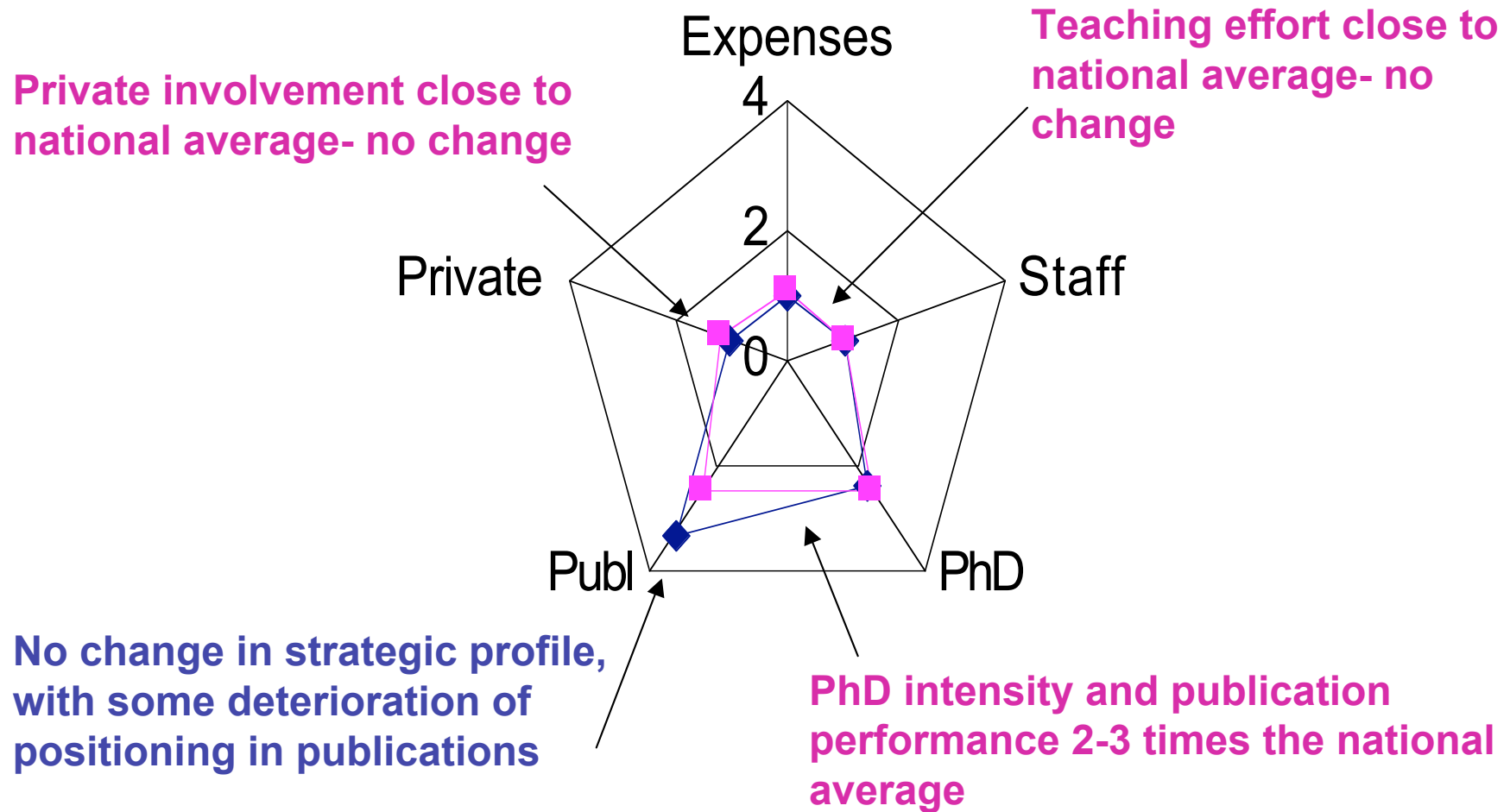
Several extensions possible on the dataset.

# Limited differentiation between universities in the same country

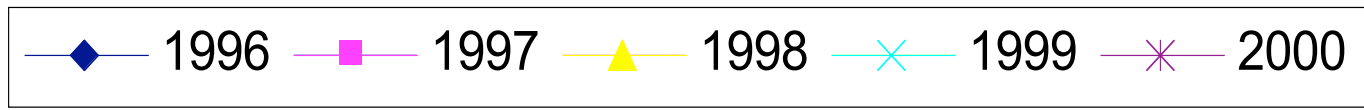
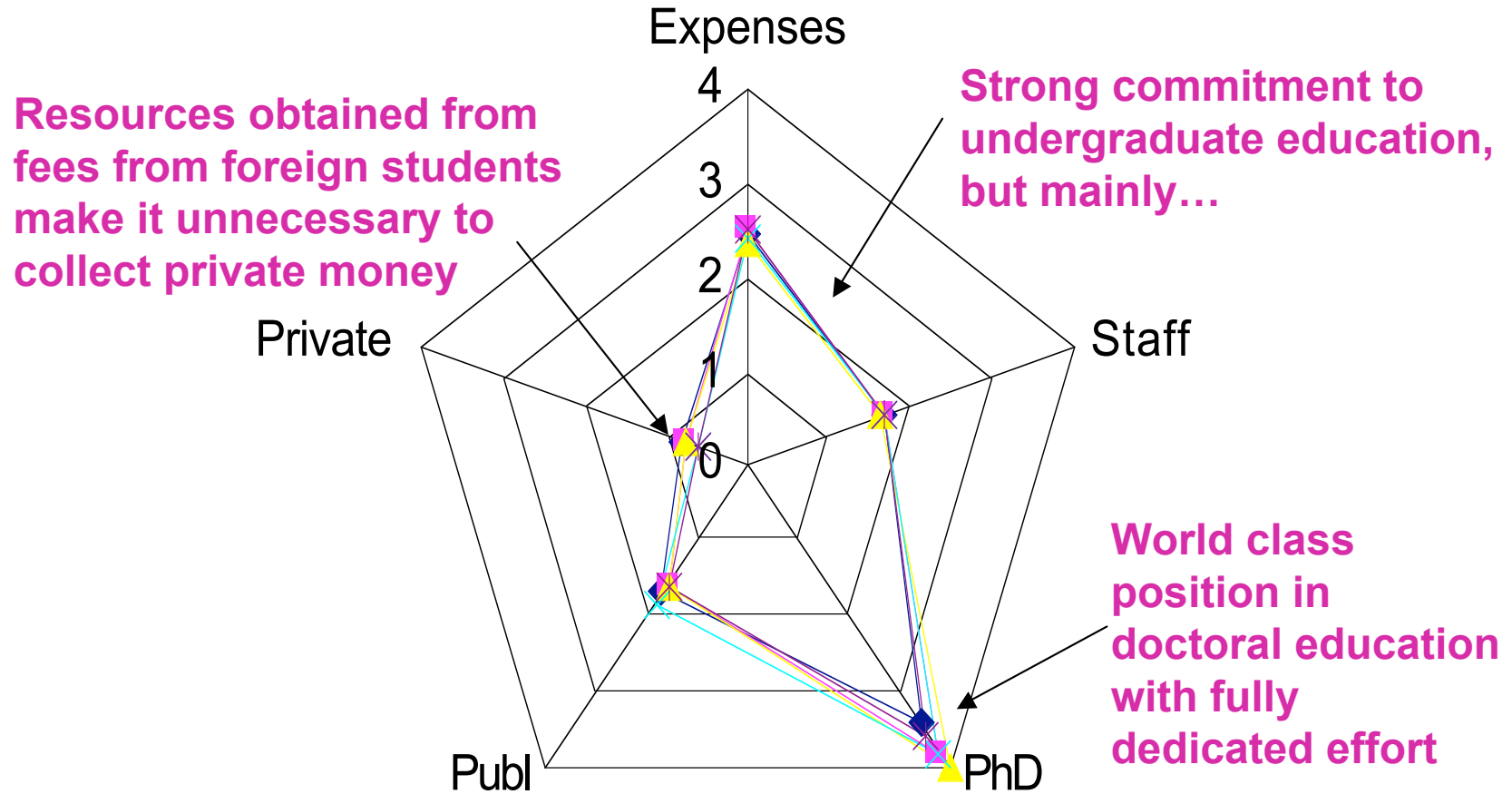


—◆— University Alfa —■— University Beta —▲— University Gamma

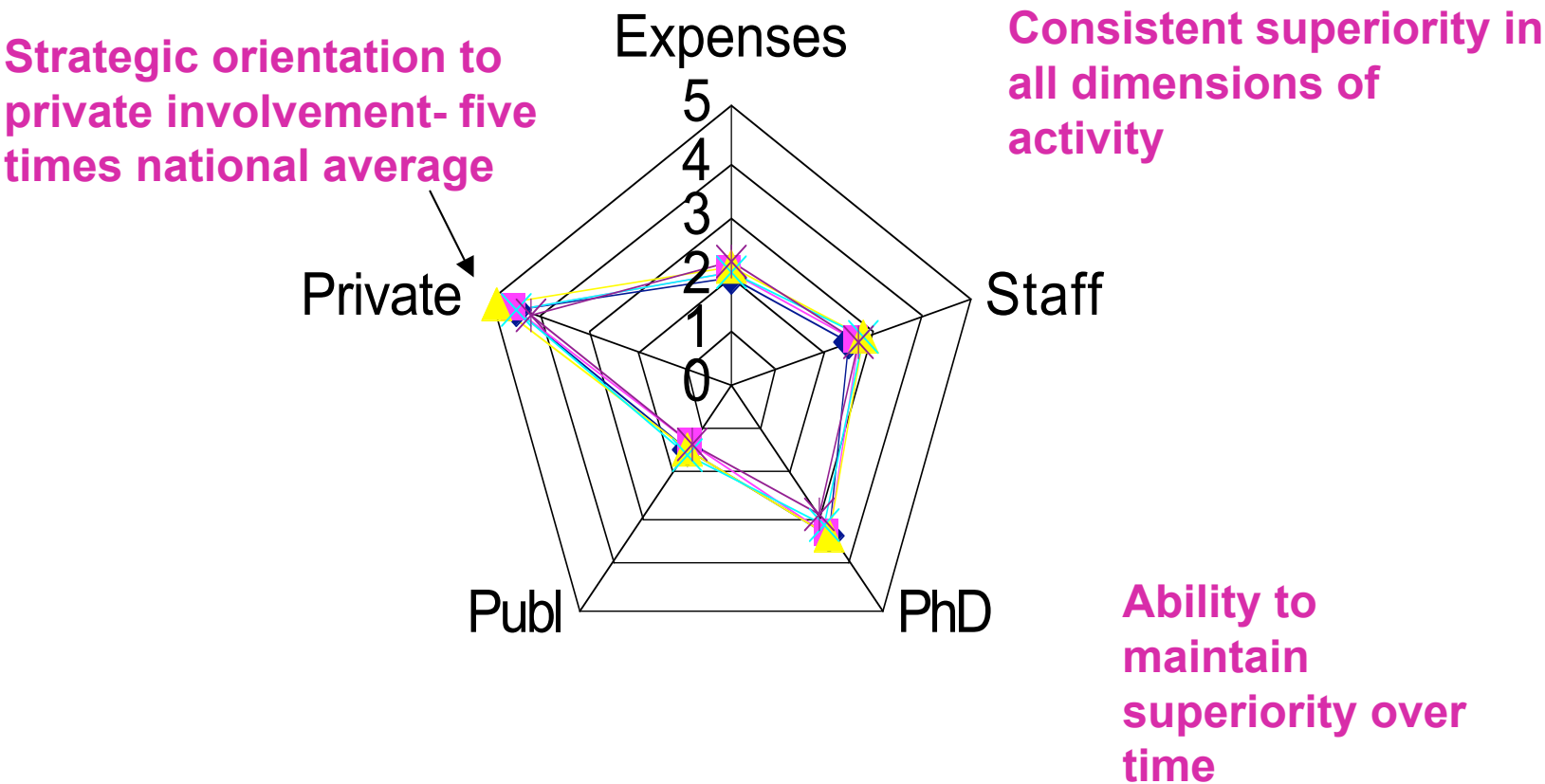
# Leading university in basic research



# Leading institution in postgraduate education



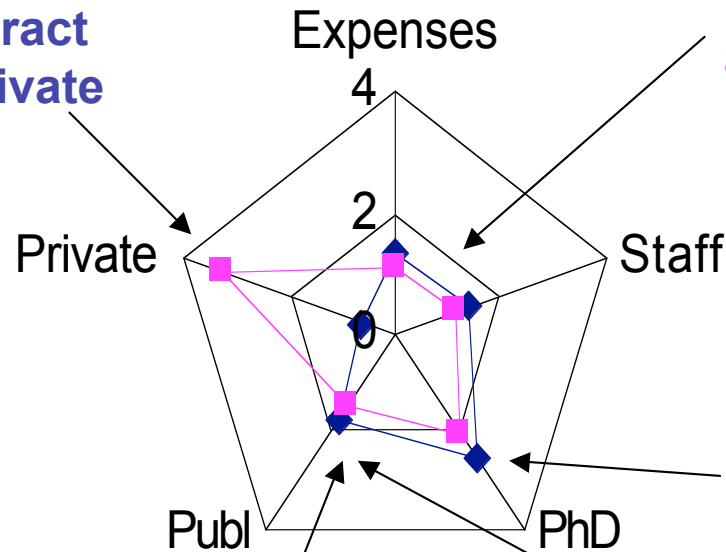
# Profile of excellence with strong private involvement



# Leveraging on research performance in order to increase private support

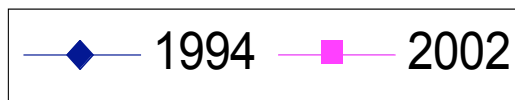
A clear strategy of increase in contract research and private involvement

Teaching profile and private support roughly in line with national average

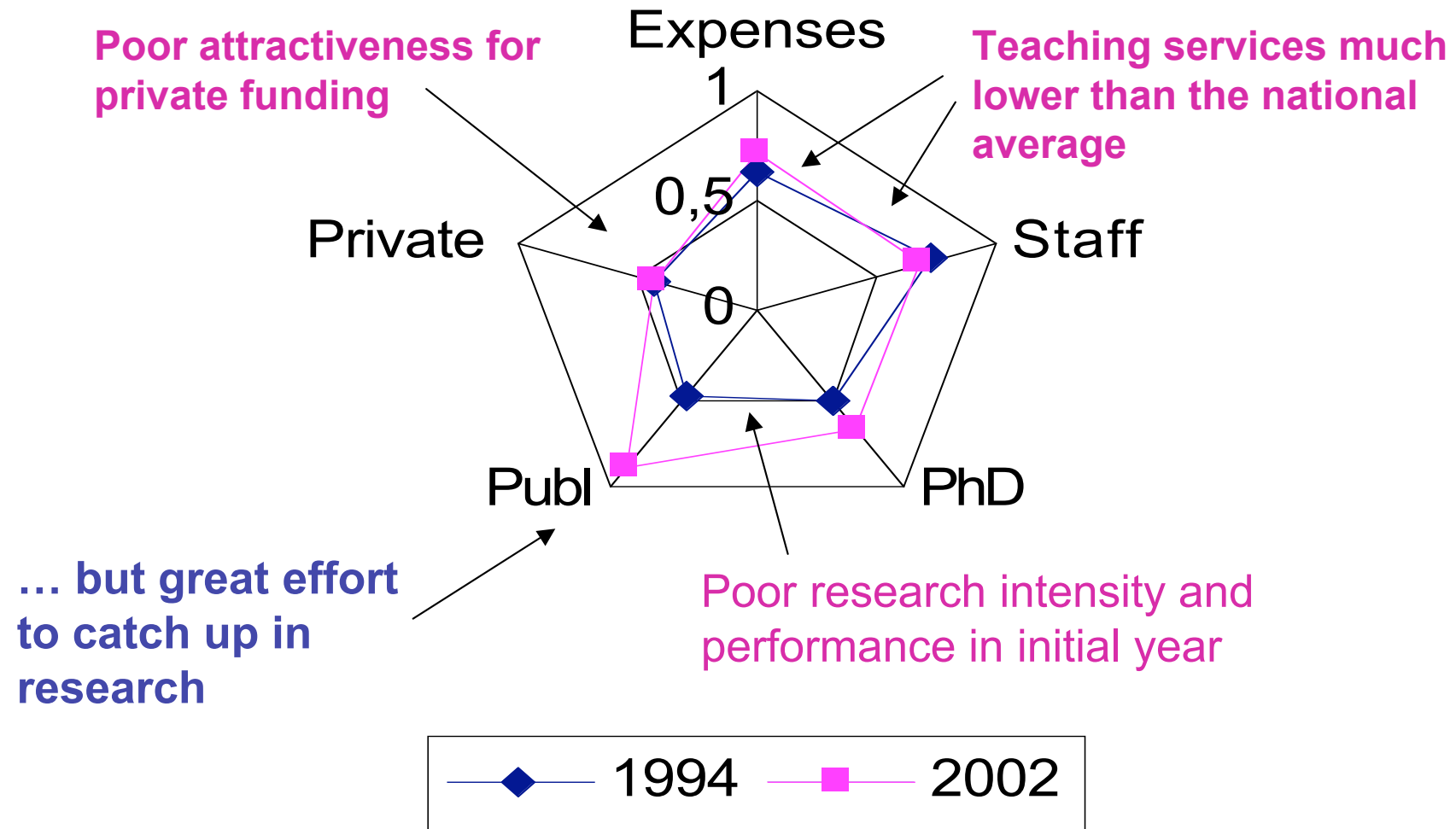


With a slight deterioration effect on pure research performance

Much better research performance



# Laggard university catching up with research activity



## Mobility analysis

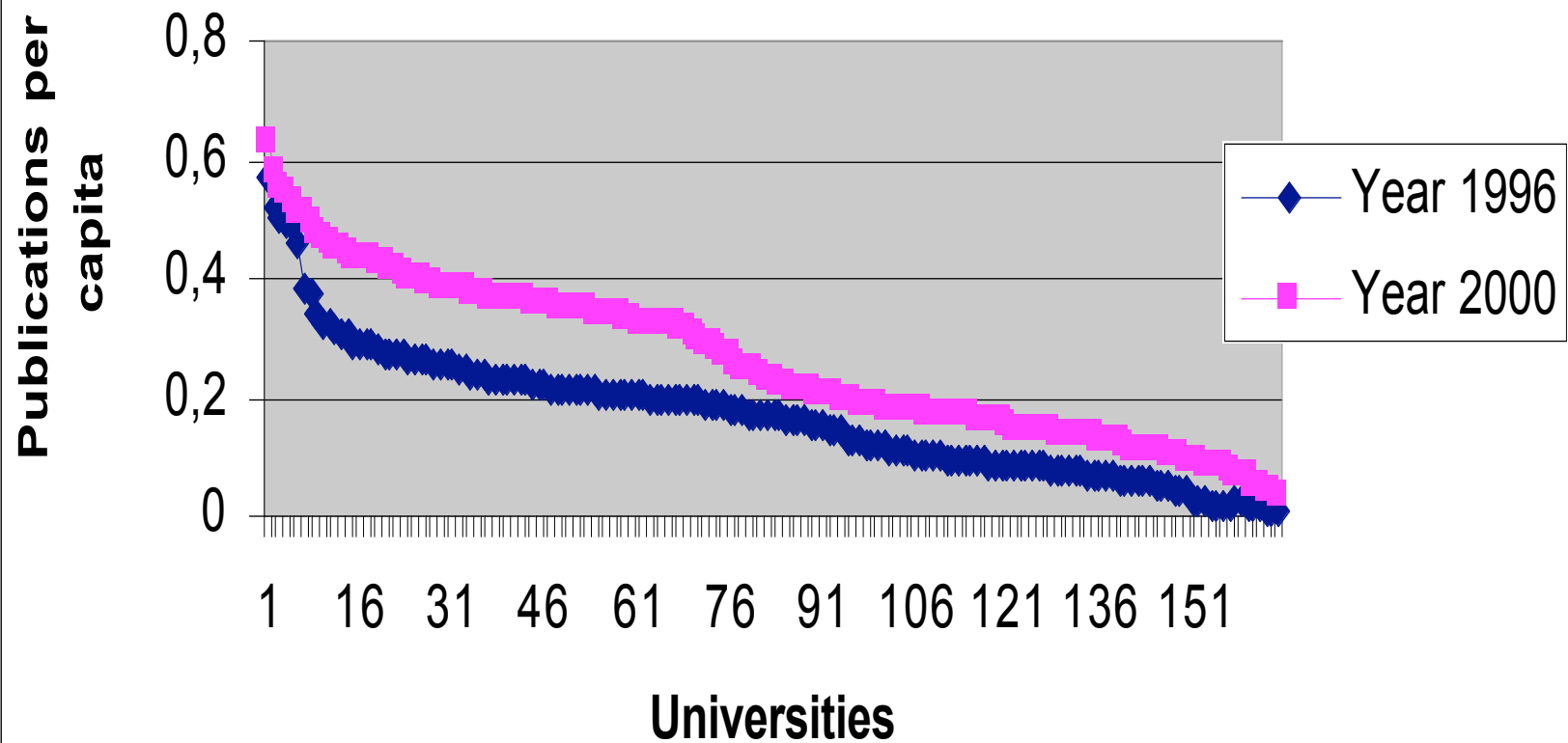
Change in ranking on individual parameters

- scientific productivity (publications per capita)
- year 1996-2000
- sub-sample of countries (full coverage time series, n= 158)

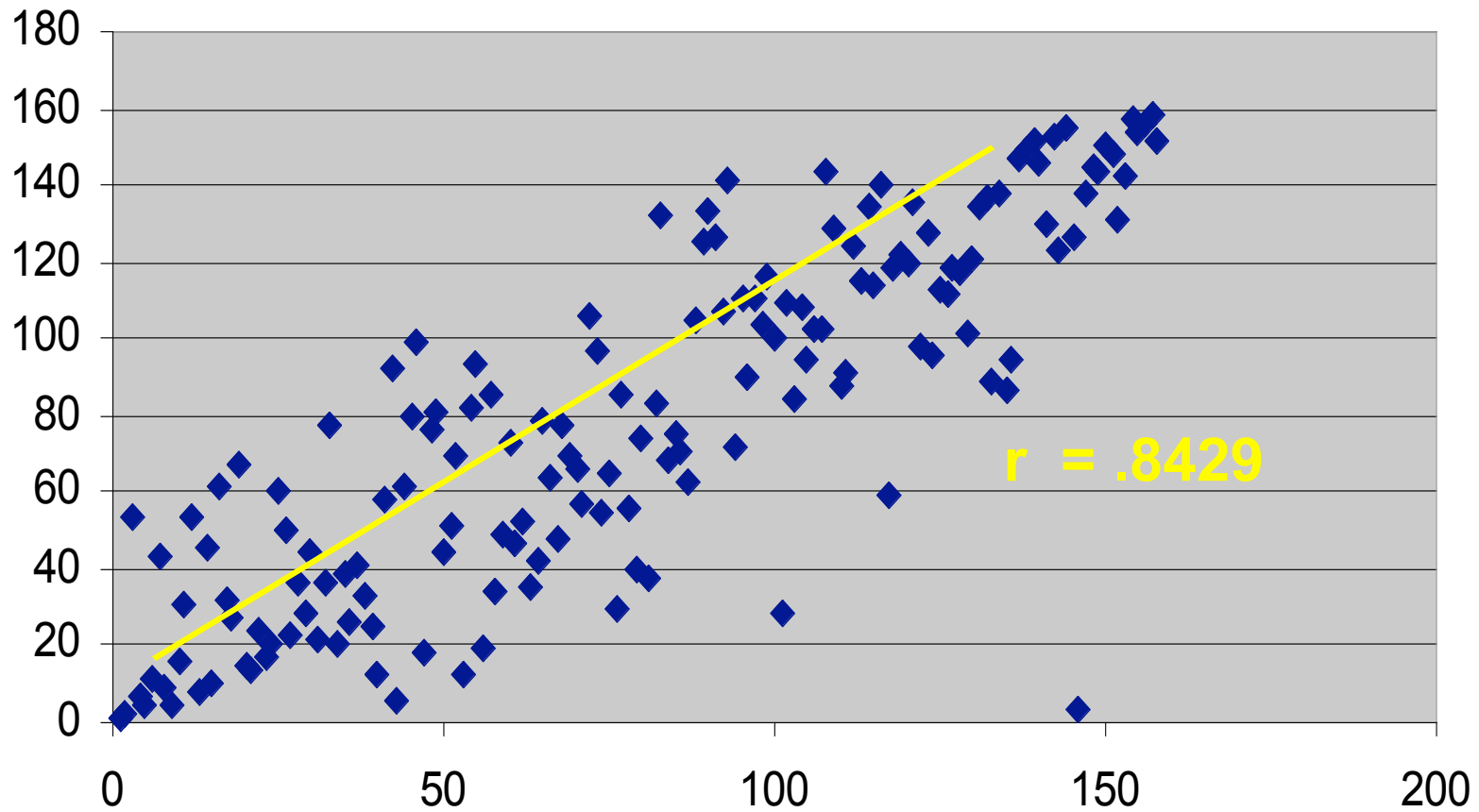
List of best/worst performers

Analysis of best performers against other dimensions of university production

# Growth in average scientific productivity of academic staff 1996-2000

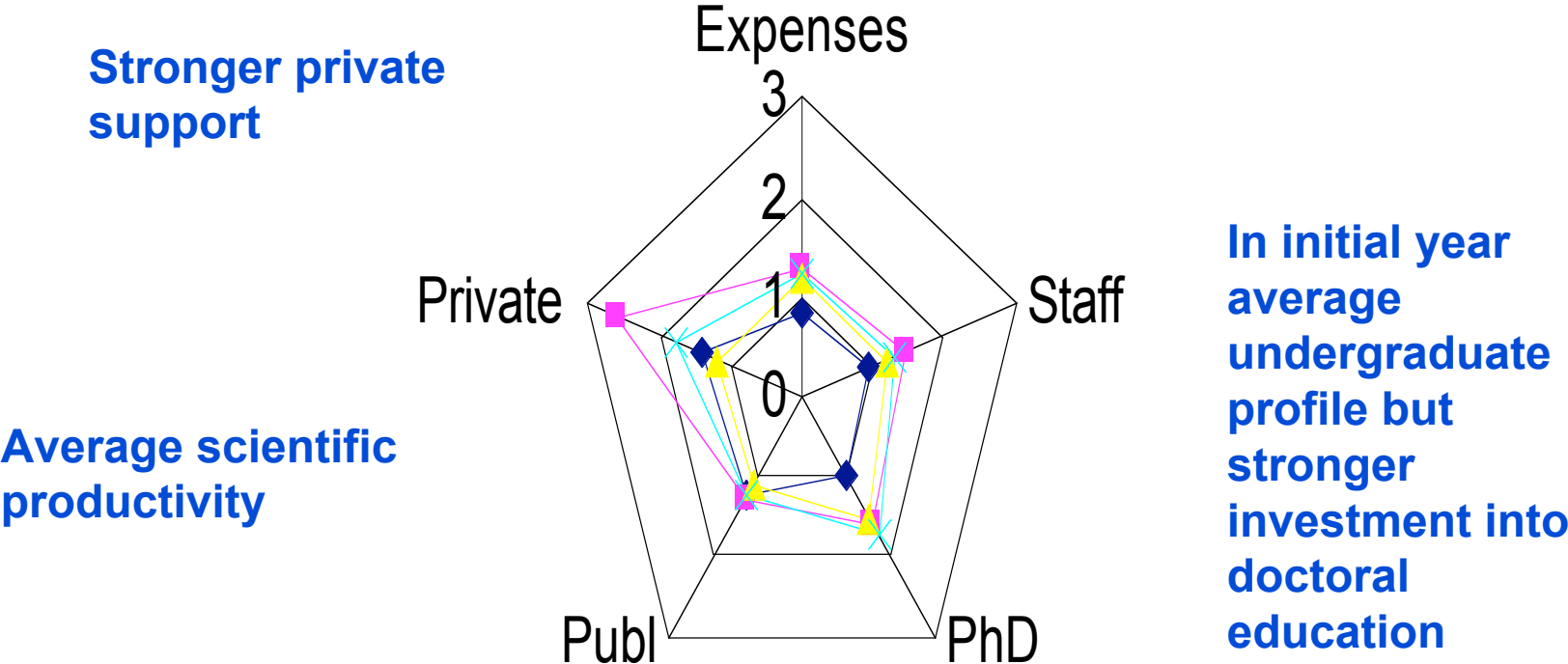


# Rank correlation in average scientific productivity, 1996-2000 (n= 158)



# Upward mobility in scientific productivity, 1996-2000.

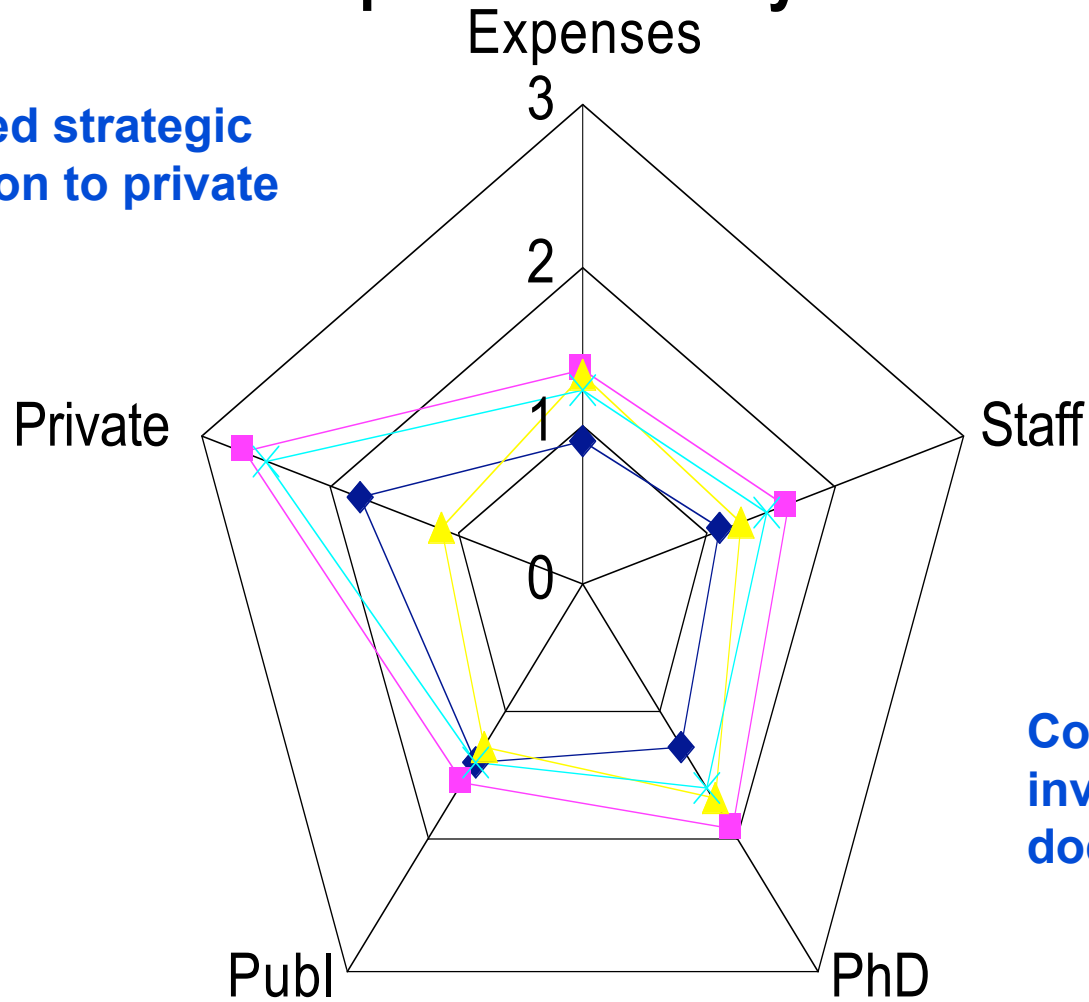
## The profile of best performers in UK (1996)



—◆— University A    —■— University B    —▲— University C    —×— University D

# Best performers in year 2000

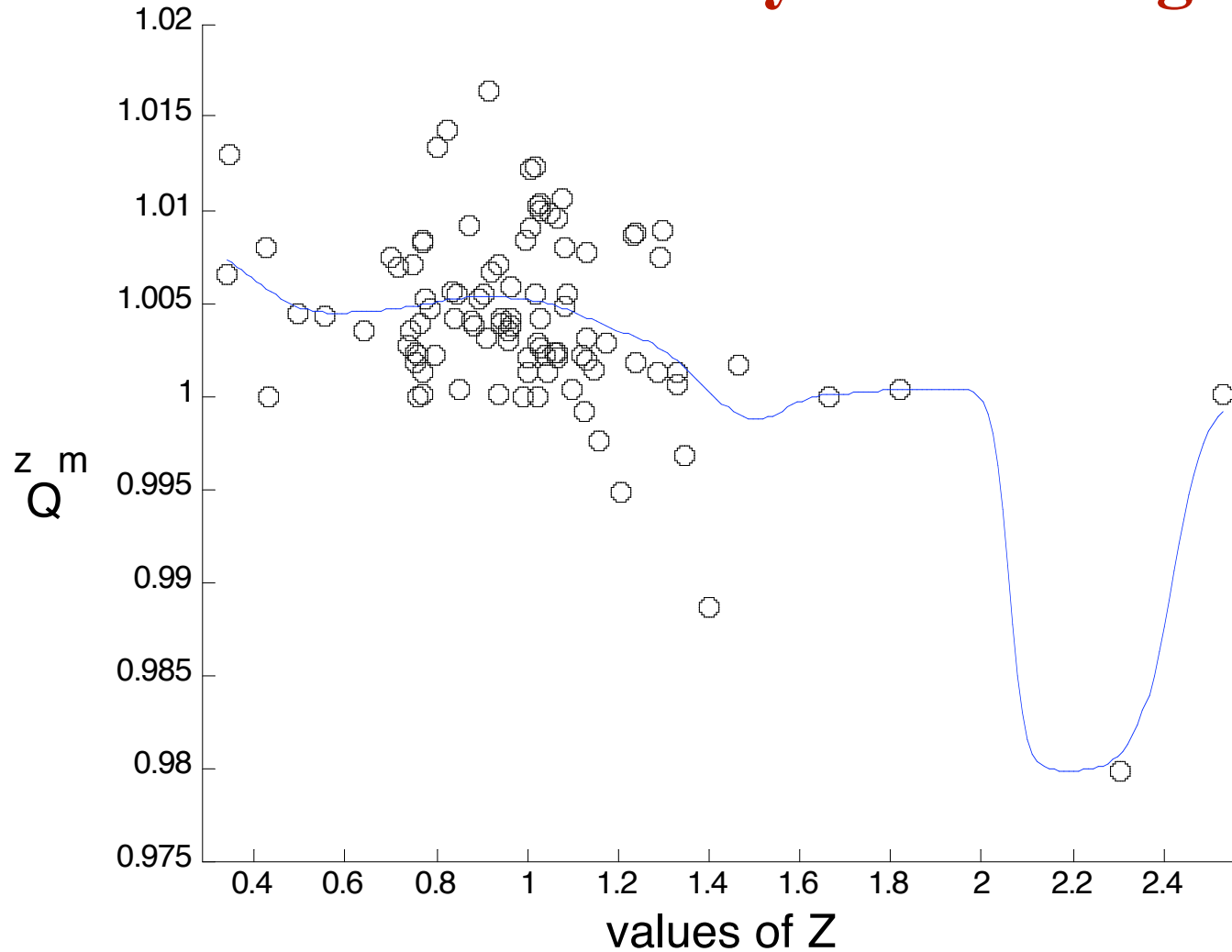
Continued strategic orientation to private support



Continued investment into doctoral education

—◆— University A —■— University B —▲— University C —×— University D

# Trade off research activity vs teaching load

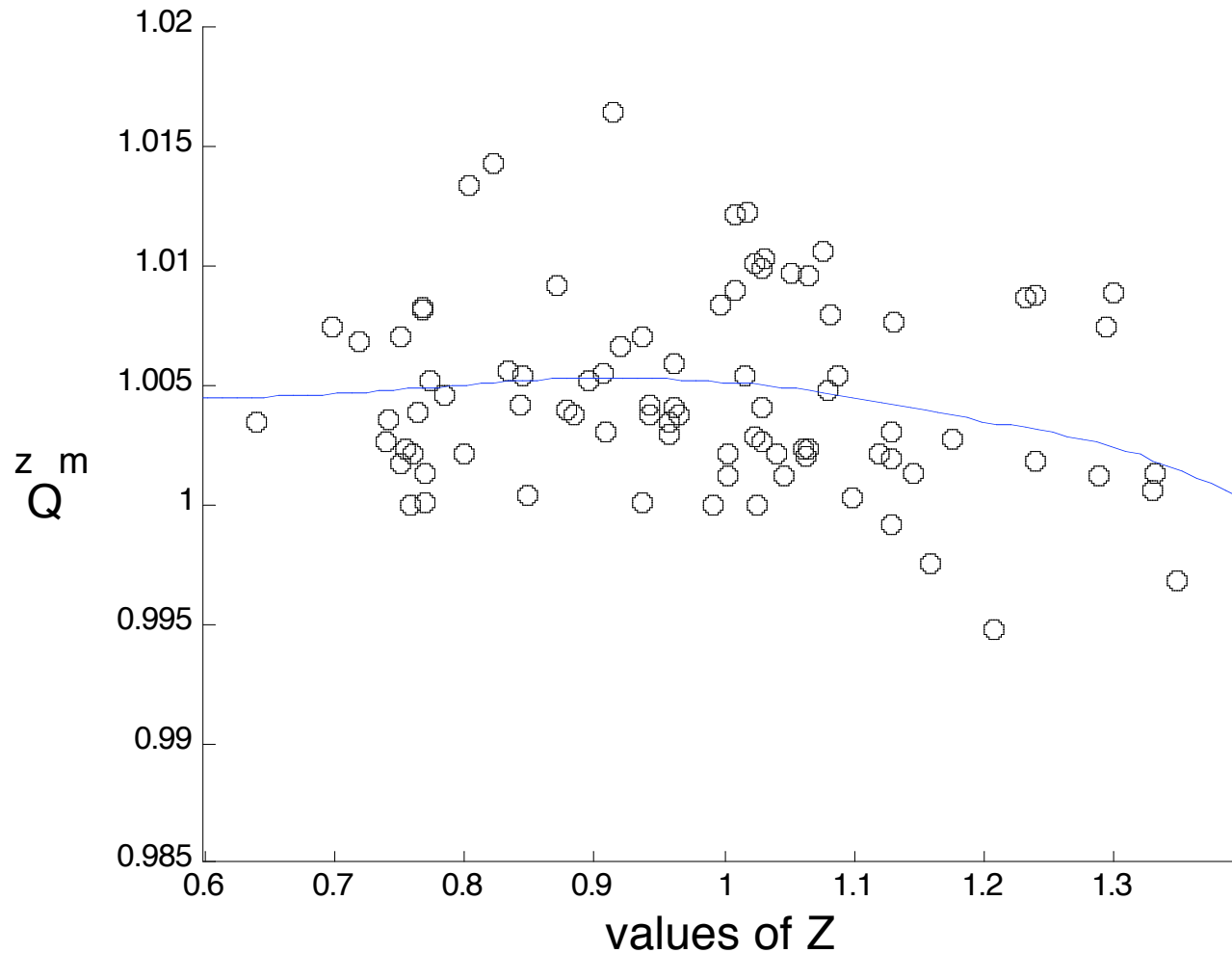


Research model (X1 =AC\_TOT, X2=TECHADM, Y=PUB, Z=LOAD).

LOAD=ENROLLED/AC\_TOT. m=20, alpha=0.96

ALL sample MEDICINE 2000 98 OBS (NORMALIZATION ON COUNTRY MEAN)

# Trade off research activity vs teaching load: a zoom

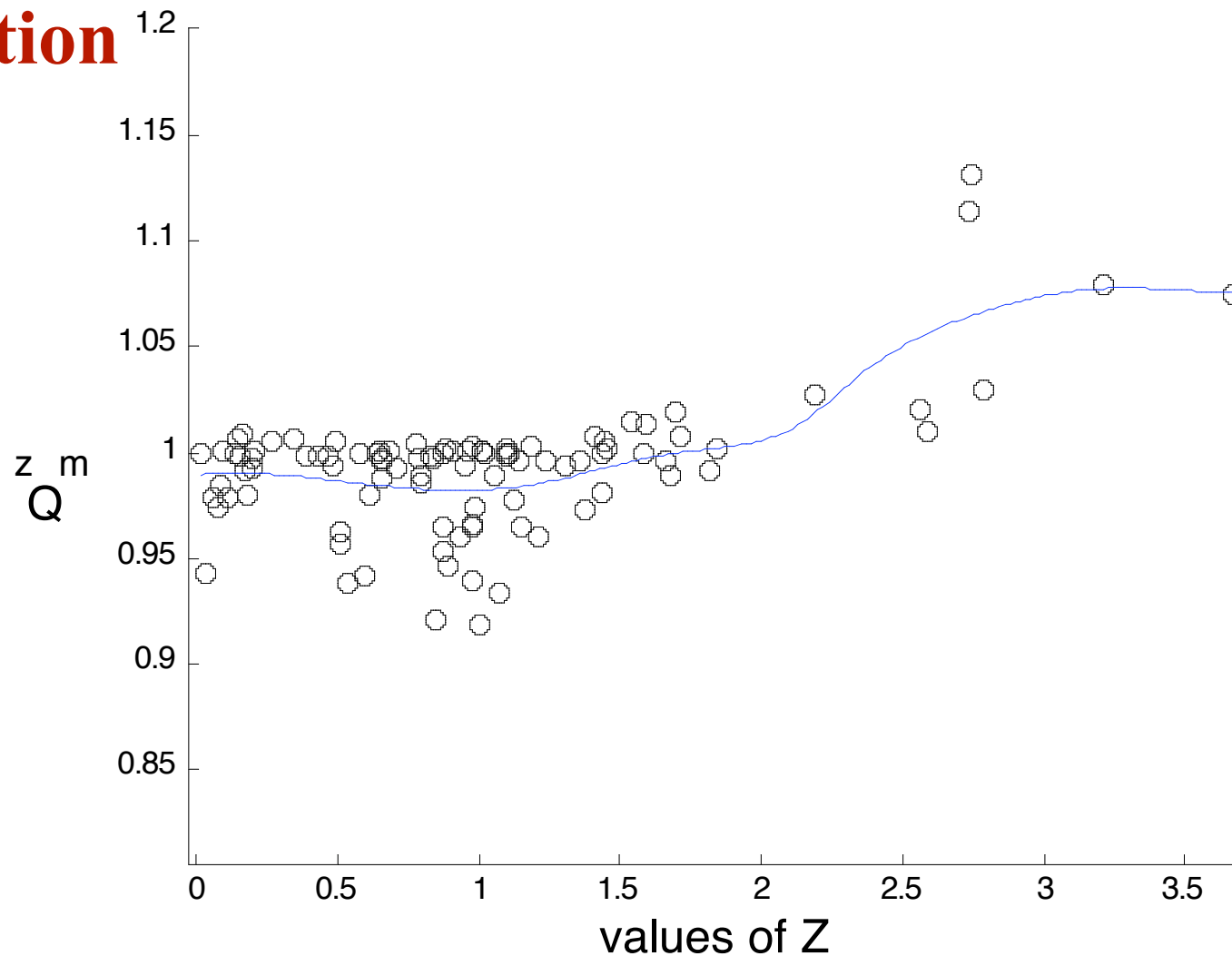


Research model (X1 =AC\_TOT, X2=TECHADM, Y=PUB, Z=LOAD).  
LOAD=ENROLLED/AC\_TOT.

ALL sample MEDICINE 2000 98 OBS (NORMALIZATION ON COUNTRY MEAN)

# Trade off research activity vs industry collaboration

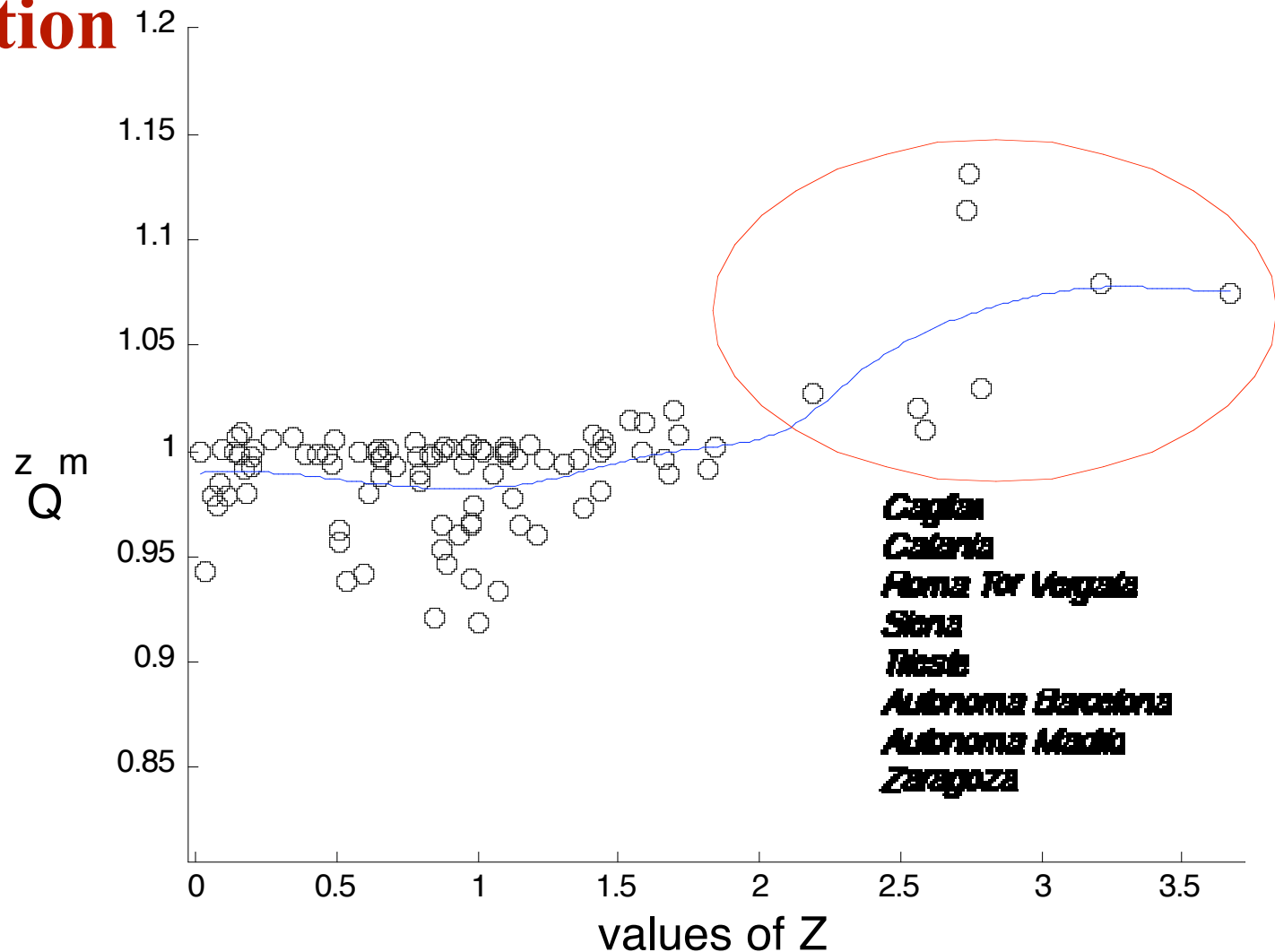
## PPRIV



Research model (X1 =AC\_TOT, X2=TECHADM, Y=PUB, Z=PPRIV).  
ALL sample MEDICINE 2000 98 OBS (NORMALIZATION ON COUNTRY MEAN)

# Trade off research activity vs industry collaboration

## PPRIV



Research model (X1 =AC\_TOT, X2=TECHADM, Y=PUB, Z=PPRIV).  
**ALL sample MEDICINE 2000 98 OBS (NORMALIZATION ON COUNTRY MEAN)**

# Ranking of universities

Methodological assumptions of ranking:

- homogeneity of units of analysis
- *value-free* weighting schemes across dimensions of performance
- commensurability of dimensions (unique metrics)

Positioning indicators:

- multidimensional performance
- trade-off between dimensions of performance
- learning about strategic behaviour of universities

## Policy issues

- Does the reform increase or limit university autonomy?
- What are the potential adaptation behaviors of universities?
- Are there unintended consequences of reforms?
- Is the government prepared to accept the possible consequences of adaptation of universities to the reform?

## The UK case study

Gustavo Crespi, *The UK production function*, in A.Bonaccorsi- C.Daraio, *Universities as strategic knowledge producers. Differentiation and performance in Europe*. Edward Elgar, 2007.

## Sources of funding

The HE funding system involves two main streams of resources:

- (1) funding from the Higher Education Funding Councils (HEFC) for teaching and some research**, administered by the Ministry for Education;
  
- (2) funding for research from the Research Councils**, for which the Office of Science & Technology (OST) at the Department of Trade and Industry (DTI) is responsible.

HEFC funds are allocated by formulae and distributed as a block grant, which institutions can spend at their own discretion. Teaching funds, the main component –roughly 75%– of the HEFC block grant, are allocated to the institutions on the basis of the number of students and a series of subject, student and institution related factors.

- Approximately **a quarter of the HEFCs budgets are allocated to research**. About 95% of these research funds are distributed selectively, according to various quality criteria. The remaining 5% is distributed according to the priorities set by each council.
- Most HEFC for England (HEFCE) research funds are distributed selectively, to HE institutions with a demonstrated strength in research based on national and international standards.
- A key component of the second resource stream in the HE system is the **Research Councils**. There are seven UK Research Councils each established by Royal Charter. The Research Councils fund direct project costs and a proportion of indirect project costs.

The **quality of research** is assessed in a Research Assessment Exercise (RAE) that is conducted every four or five years. The most recent assessment was in 2001, the results of which are informing funding decisions from 2002-03 on. Institutions were rated in the last RAE, on a scale of 1 to 5\*, for the quality of their research in every sub-field (unit of assessment) in which it was active.

Ratings 1 and 2 attract no funding, while a rating of 5\* attracts approximately four times as much funding as a rating of 3b for the same volume of research activity, which makes HEFCE's funding of research highly selective.

**In 2001-02, 75 per cent of HEFCE research funds went to 25 higher education institutions.**

## Pattern of growth in funding

Total funding to UK universities has grown at a rate of almost 3%, in real terms between 1996 and 2003.

The different sources of funds show divergent trends. While student fees grew at only 3.5% per year and government funding expanded at 2.4% p.a.; the other sources showed much higher growth rates:

- private funding (industry and charities) grew by 7.4% p.a.;
- EU plus other international funding increased at 5.3 % per year
- other funding - such as services provided by the university (including consultancy, housing, catering, conferences, leasing) and income from financial and real estate investments grew at 3.2% p.a

# Stylized features of the UK system

## **Separate channels of funding** for teaching and research:

- different institutions (HEFC vs DTI- Research Councils)
- different criteria and formulae
- competitive allocation

## Systematic **evaluation of research**

## Increase in the **share of private funding**

## Consequences:

- **differentiation** of university profiles and emergence/ consolidation of the "research university model" (De Fraja, 2004; Dewatripont et al. 2005)
- **concentration** of resources
- pressure for non-top universities to look for research funds different from Research Councils (e.g. private)

## Possible unintended consequences

### (a) Concentration does not lead to more efficiency

When considering R&D (stock) in combination with other research inputs, such as support and academic staff, there is some evidence of decreasing returns to scale at university level. In other words, it seems that the concentration of resources in large research units does not necessarily lead to an increase in research productivity

### (b) Private funding increases total research output but damages international publication

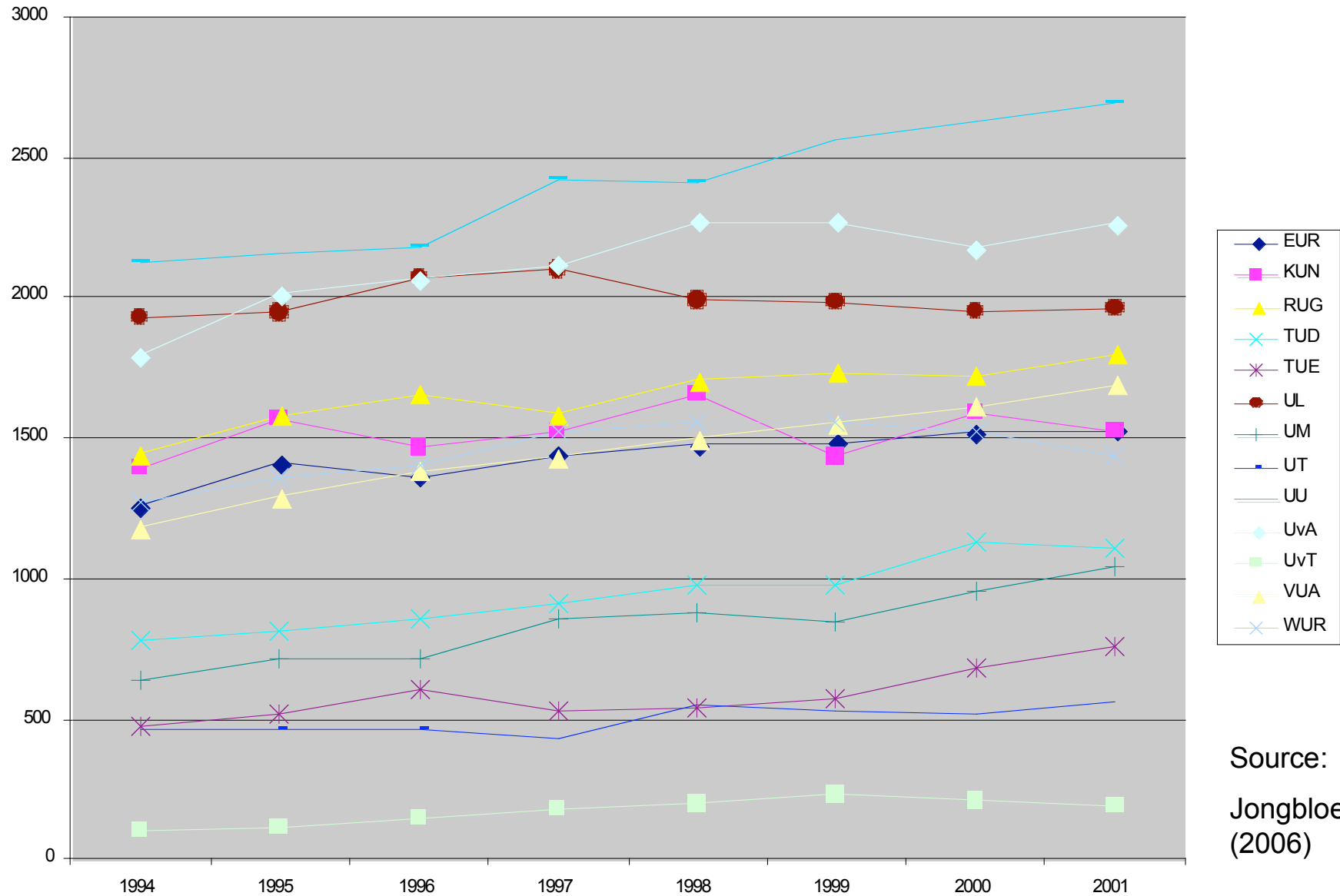
Our results seem to suggest that the increasing role for external funding from international organisations and the private sector is damaging to research productivity when research output is measured by journal publications. External funding from international organisations and the private sector would also change the composition of the research set, leading to a larger importance of outputs other than journal publications.

## University research strategies in the Netherlands

- ✓ Creating “centers of excellence” (selectivity, critical mass, profiling)
- ✓ Reform of financial/budgetary instruments
- ✓ Strengthening the centre’s steering capacity (managerialism)
- ✓ Collection of information on research/teaching performance & environment
- ✓ Support facility to help researchers in revenue generation and research commercialisation
- ✓ Devolving responsibility to departments (responsibility based management)
- ✓ More flexibility and performance-orientation in human resources management
- ✓ Engaging in linkages with the outside world (region, industry, SME)
- ✓ Alliances with other universities (at home and abroad)

Source: Jongbloed (2006)

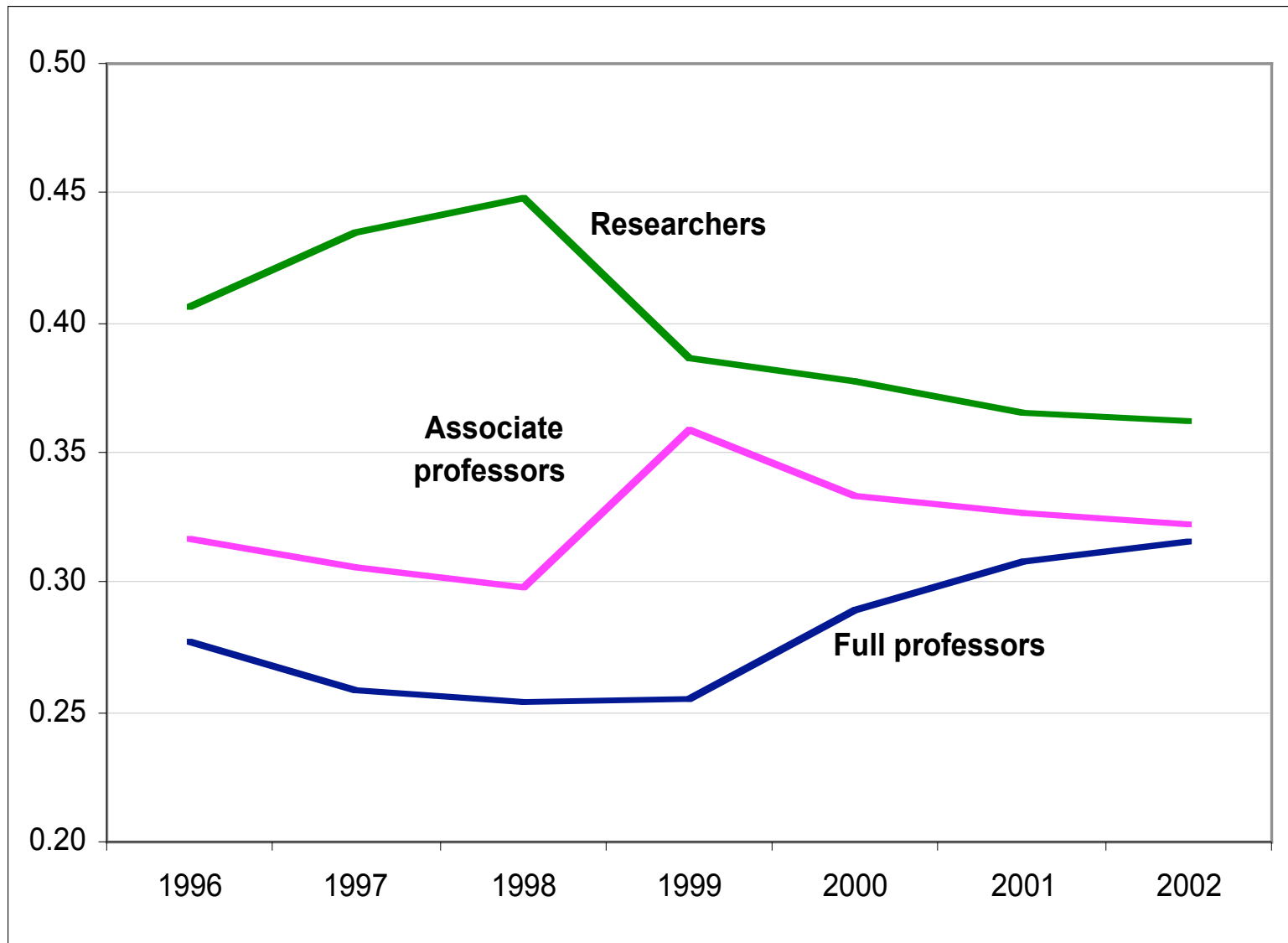
# Publication output per university in Netherlands



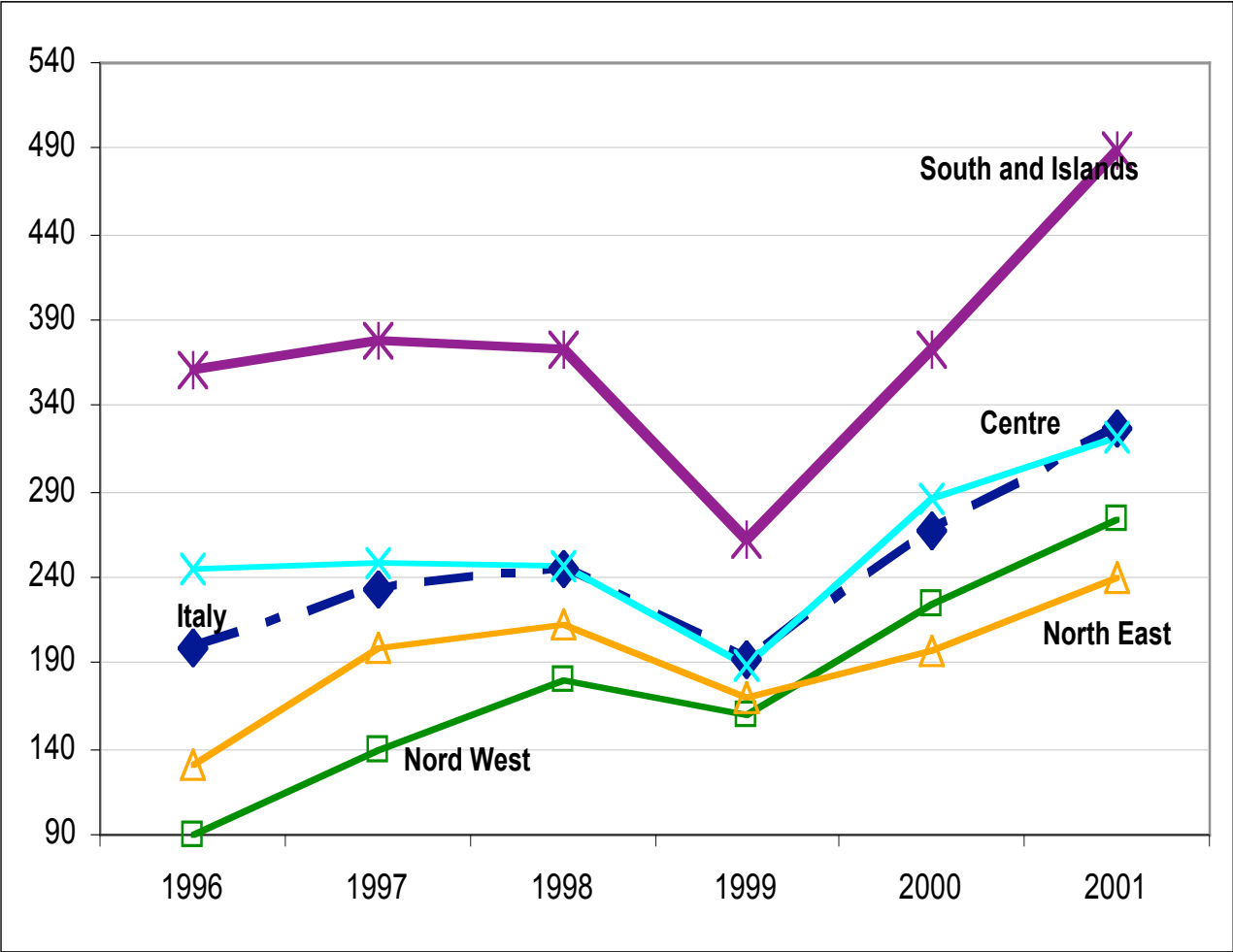
Source:  
Jongbloed  
(2006)

## The case of Italy

**Figure 7.2. Composition of academic workforce (%). Full professors, associate professors, researchers.**



**Figure 7.4. Total expenses per unit of scientific publication (thousand Euro)**



This unintended outcome is particularly damaging for the Italian system, which is one of the less differentiated higher education systems. In Kyvik's (2004) terminology, Italy is the only "university dominated system", that is, one in which all higher education, including vocational training and skill-related training, is managed under the exclusive responsibility of universities.

In order to cope with these issues and to increase the level of education of population Italy adopted rapidly and massively the Bologna scheme, using it as an opportunity to redesign the whole educational supply. Data show that this move has been successful, raising participation rates and greatly increasing the number of degrees awarded.

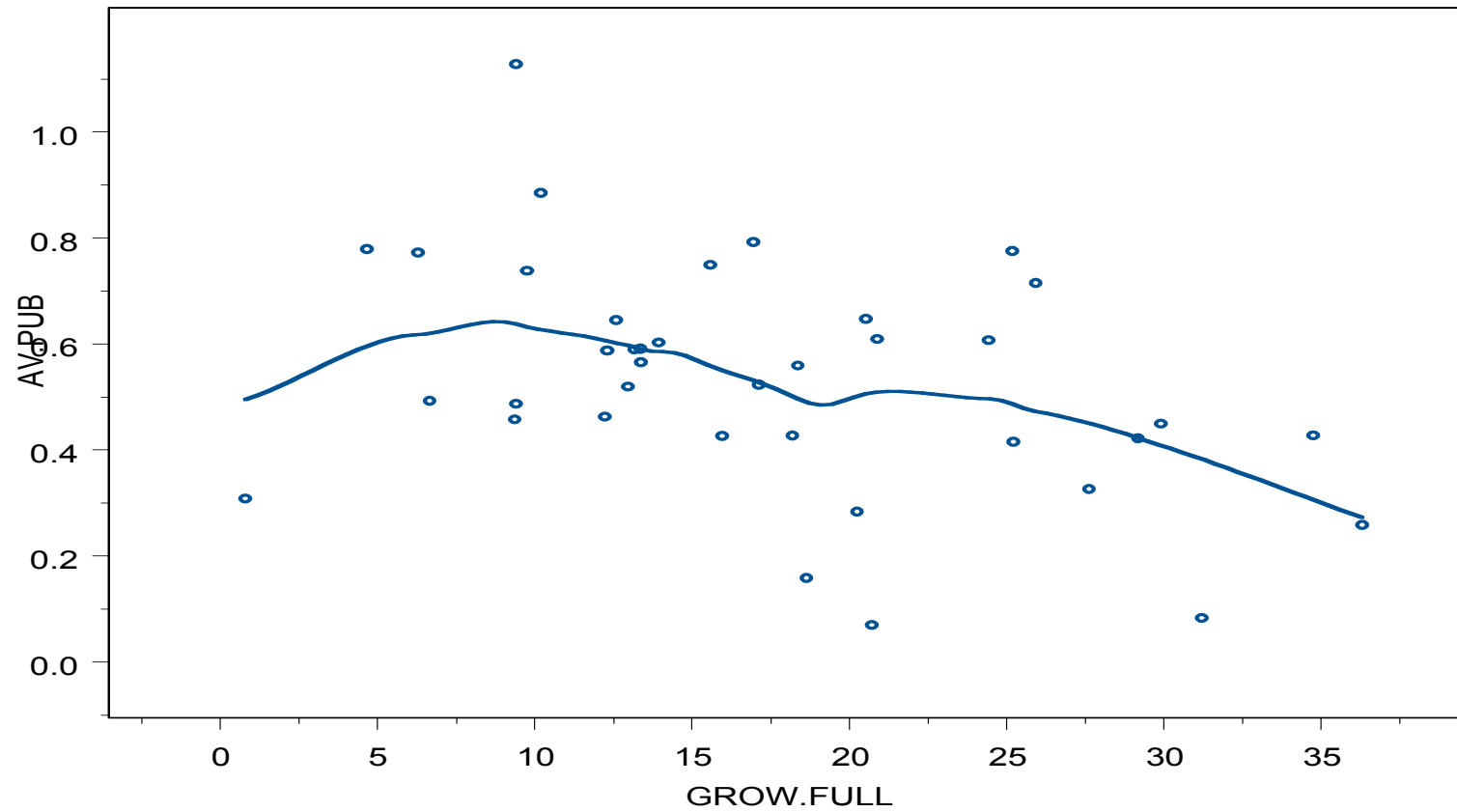
The cost of this change, however, has been a massive refocusing of universities on undergraduate teaching.

Consequently, the promotion of old researchers and professors with a poor record in research, but reasonable teaching skills, has found some legitimation and has become an accepted practice.

Young and highly productive scientists are often kept for long time in a non-tenured position.

In the absence of institutional differentiation towards research, in a few years universities have witnessed a deterioration of scientific performance.

**Figure 7.5. Rate of growth of the share of Full professors (GROW.FULL) on average scientific productivity (AV.PUB)**



## Conclusions

Promising approach

Combining quantitative analysis and qualitative understanding of dynamics of change

Use positioning indicators for multiple uses:

- academia
- university administrators
- policy makers
- researchers

Need to integrate/ validate/ standardize/ create report formats/ diffuse