# An overview

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Universities are the object of a renewed policy interest. Governments and international institutions recognize the central role of universities in the so-called knowledge society and call for their increasing involvement in social and economic problems.

However, we are faced with an interesting paradox: while we are told that in the twenty-first century the real and valuable resource is knowledge – not capital, not the workforce, not raw materials – we know very little about the main knowledge producers, that is, universities.

This book started from a risky bet. We wanted to develop a quantitative approach to the analysis of universities, by taking individual universities as units of observation. In other words, a micro-based approach was called for. Data should not be primary data collected at universities, but secondary data, available at the ministerial or other institutional level in each country, and neither published nor not made comparable across countries. The project wanted to explore the availability, accessibility and comparability of existing data, and the feasibility of an integrated dataset at the European level. Countries were selected with the simple criteria of having secondary data available and accessible by researchers. In the first round, Aquameth 1 (Advanced quantitative methods for the evaluation of the performance of public research systems), on which this book is based, six countries were selected: Italy, Norway, Portugal, Spain, Switzerland and the United Kingdom. A second project, already started (Aquameth 2) extends the research to France, Hungary and the Netherlands.

This differs sharply from the approach followed by main international organizations, governments and policy analysts, which use statistics at country level, aggregated according to the Frascati and Oslo manuals. In aggregate statistics you observe only one moment of the distribution (average value) and totally ignore other moments of the distribution and associated indicators, such as range, variance, coefficient of variation or skewness. Educated on this type of indicator, policy makers routinely state that 'investment in R&D is $x$ per cent of GDP' or that 'the share of public funding on R&D is $y$ per cent' – clearly relevant information, but of little value to address more sophisticated policy issues. This is even more so if we

consider that virtually no variables of interest for policy making have a normal distribution. For example, scientific productivity of researchers is known to have a highly skewed distribution, due to cumulative factors, path dependency and self-selection. Another extremely skewed distribution is the number of citations received by scientific articles: due to both the distribution of quality of research, and also visibility effects and constraints on attention, a few articles receive a disproportionate share of citations, while a large number receive none. Now, universities are organized collections of individuals and teams whose activity produces non-normal distributions of output.

How are these individuals collected together? How do institutions organize academic work and what are the consequences? How do different activities (teaching, research, the 'third mission'), each characterized by different distributions of individual output, but also by positive and negative complementarities, combine together? And are there robust implications for policy makers, administrators and academic staff?

The construction of a dataset for analysis at the micro level is a daunting exercise. There is no standardization of definitions and statistical units. Institutional differences are so large that the same word means totally different things in different countries. National policies have profound effects on the university system, so that the research design should incorporate a regular update of legislative and administrative changes. The Aquameth project, set up under the Network of Excellence PRIME (Policies for Research and Innovation in the Move towards the European research area), addressed this issue by developing a multi-method approach.

First, each country in the initial project has been covered by an extensive case study, pointing to recent changes in policies and main trends. National case studies allow us to consider the heterogeneity of institutional frameworks, and also the ever-changing impact of policies. Second, comparative analysis has been carried out on some transversal issues that are at the core of the policy-making debate. Finally, in the cases in which the comparability of data was demonstrated, an integrated analysis of the dataset has been carried out. This is a major step in the economics and political science of higher education, since most existing literature is based on either national datasets or comparative analysis. It is the first example, to our knowledge, of the construction of a large dataset on European universities.

The volume is also deliberately pluralistic in methodological approaches. As an example, in addressing problems of academic production and efficiency, Crespi (Chapter 9) adopts a parametric, knowledge-production function approach, Filippini and Lepori (Chapter 8) utilize a flexible quadratic cost specification, and Bonaccorsi, Daraio and Simar (Chapter 5)

use robust nonparametric techniques. In future work, different methodologies will be applied to the same dataset.

After the introductory Part I, which sets the stage for analysis, the book is developed in three further parts, covering theoretical and transversal policy issues, country case studies, and methodological problems.

In Part I, Andrea Bonaccorsi and Cinzia Daraio (Chapter 1) develop a theoretical discussion on the notion of strategy, as relevant for universities. While this notion has repeatedly applied to universities in the context of the literature on new public management and entrepreneurial universities, its content is still not determined clearly. The authors propose that universities have emergent strategies (rather than deliberate), which can be defined and (possibly) measured as positioning in the multidimensional output space.

Strategic thinking requires the long-term, partially irreversible commitment of resources to positioning in this space, realizing the best possible use of available resources at any time.

The notion of university strategy is operationalized in Chapter 2, also by Bonaccorsi and Daraio. They use the Aquameth dataset to develop indicators of strategic positioning in the output space, and examine the strategic autonomy in terms of financial resources. They show that several universities try to differentiate themselves by assuming specific positions in the multidimensional space of outputs, for example by specializing in post-graduate education, hiring the most productive scientists, or expanding rapidly their undergraduate student education programme. At the same time, the process of specialization and differentiation is severely limited by institutional constraints at national level.

Part II deals with transversal topics. Reporting from an EU-funded project, 'Changes in University Incomes: Their Impact on University-Based Research and Innovation' (CHINC), Benedetto Lepori, Martin Benninghoff, Ben Jongbloed, Carlo Salerno and Stig Slipersæter (Chapter 3) provide a comprehensive review of the evolution of funding structure. Contrary to part of the literature, they show that overall funding per student did not decrease in the 1994–2002 period. The overall share of government funding ranges between 65 and 75 per cent for most countries, with the notable exception of the UK. At the same time, for a group of proactive universities, there is also significant diversification of sources of funding. For example, they identified a list of universities for which the share of grants and contracts exceeds 20 per cent of the total university budget. This group includes well-known technical universities, but also generalist universities that have aggressively pursued the integration between fundamental research and applied contract research.

The issue of integration of traditional missions of universities with new missions towards society and the economy, conventionally labelled the

'third mission', is the subject of Chapter 4, by Magnus Gulbrandsen and Stig Slipersæter. Defining and collecting indicators of the third mission has been extremely difficult. There is no currently accepted definition and data integration has proved to be almost impossible. Based on this contribution, the new Aquameth 2 project is trying to identify a common set of comparable indicators across countries. Meanwhile, the authors use the existing limited indicators in Aquameth 1 and integrate them with detailed data coming from national surveys in Scandinavian countries. They show that highly productive scientists tend to perform well in both scientific and third-mission dimensions.

Chapter 5 introduces efficiency analysis. A large literature in the economics of higher education has used nonparametric techniques, such as data envelopment analysis (DEA), to investigate efficiency in the relation between inputs and outputs. The intrinsic limits of DEA have, however, produced fragmented and inconclusive results, placing some discredit on the whole research field with respect to higher education. In this chapter, Bonaccorsi, Daraio and Léopold Simar introduce the latest developments of robust nonparametric techniques and apply them to the Aquameth dataset. They address a number of highly debated issues, such as the existence of economies of scale in education or research, the role of the PhD in scientific productivity, and the effect of contract funding on scientific productivity. One of the major themes of this chapter is that empirical findings of interest to policy making may have *local* effects, that is, an estimate of the average effect (for example, slope of a regression line) may fail to capture the variability.

Part III deals with national case studies. Each group of authors has taken a policy issue that is at the core of debate in the respective country. Taken together, they give an updated account of changes taking place in higher education systems under the joint pressures of further massification, increasing societal demand, and world scientific competition.

The Swiss system is well known for its highly differentiated structure, with complementary roles of cantons and the Federal state. In Chapter 6, Lepori examines the various typologies of higher education institutions, the sources of funding, and the changes in activity. One major theme is that the internal differentiation has allowed Switzerland to manage a steady increase in the level of education together with the creation of specialized universities, mainly in technical and scientific fields, which can compete on a world basis.

In Chapter 7, Bonaccorsi and Daraio examine the Italian case. After a brief sketch of the governance of the system, they focus attention on two policy changes, the attribution to universities of financial autonomy for the academic staff budget, and the reform of national procedures of academic promotion.

The introduction of autonomy in the 1980s has been followed in the 1990s by complete self-management of the budget, while the government still manages financial transfers. The authors show that the strategic autonomy of universities is severely limited by constraints on the budget, and by the difficulty in articulating sources of funding. Regarding promotion, they examine an intriguing case of unintended consequences of a positive reform, and call for deeper regulatory analysis of policy changes.

In various countries governments use the notion of cost per student to manage the long-term financial planning of universities and the allocation of yearly funds. The underlying assumption is that cost per student is normally distributed and is a reliable policy indicator. In Chapter 8, Massimo Filippini and Lepori show that this is not the case, because of significant subject mix effects. What is evident is that interdisciplinary differences are more pronounced than differences across universities, so that cost per student is significantly influenced by the subject mix. Mobility across disciplines, therefore, determines large variations in fund allocations. The problem of subject mix is very difficult from a methodological point of view, because we lack substantive theory and also because data are lacking. Clearly this is an important topic for further research.

In Chapter 9, Gustavo Crespi provides a detailed picture of research activity in UK universities, combining Aquameth data with data from the last Research Assessment Exercise (RAE). The UK system has witnessed a tremendous expansion in population, with the explicit goal of achieving universal participation rates, while increasing research productivity and scientific leadership. In the terms discussed in Chapter 1, one can observe the large benefits of a highly differentiated system. Another interesting result is that the growth in private contract funding is associated with a decrease in scientific production as measured by international publications, and with an increase in other types of research output.

In Chapter 10, a group of scholars from Portugal, Pedro Teixeira, Margarida F. Cardoso, Cláudia S. Sarrico and Maria João Rosa examine the changes on the road to improvement of the higher education system. Being a small country, Portugal has suffered from significant brain drain and has tried to expand higher education while retaining good scientists. Recent policy changes include the increase of project funding and the adoption of an internationally orientated system of evaluation. The overall level of academic staff has steadily increased, as well as international scientific production. At the same time the authors emphasize the difficult issue of how small, medium-income countries can compete in international research and human capital mobility.

The chapter on Spain, by Adela García-Aracil (Chapter 11), focuses on the impact of regional differences in university activity and efficiency. Spain

is a country in which the institutional responsibility for universities is allocated to regional governments, while the national government retains the right to accreditation and defines policy guidelines. Given the large socioeconomic differences among regions, the question is whether the presence of universities in a given territory may help to reduce disparities, contributing to growth. The chapter shows that while this goal has been reached in a number of catching-up regions, it is still far from realized in less-developed ones. The linkage between academic presence and activity and regional growth is an area of increasing interest.

Part IV, on methodological issues, tools and data platform, includes three chapters.

Chapter 12 is a methodological reflection on the problem of data integration at the European level, by Bonaccorsi, Daraio and Lepori. The Aquameth project has pioneered the integration of micro-based data on the university system. A large number of comparability issues are still open and deserve attention. Several techniques can be used to overcome the limitations of data, but clearly a more systematic and comprehensive approach is needed. It is important that the task of standardization and collection of data is assumed by some institution at international level, leaving researchers the task of developing new indicators and offering a theoretically-driven understanding of reality.

Chapter 13, by Slipersæter, describes in detail the variables representing the heterogeneous topography of the European higher education landscape. This list of variables comes from the work done within the Aquameth project, adopted with minor modifications by the CHINC project.

Finally, in Chapter 14, Peter Bogetoft, Harold O. Fried and Philippe Vanden Eeckaut criticize the current approach to benchmarking, showing that the comparison between units and isolated reference points (best in class, average, worst) may be misleading. This is particularly true in the case of universities. As an alternative they propose an approach that allows the analysis to identify the groups that, with respect to any unit of interest, dominate (produce more outputs using less inputs) or are dominated (produce less outputs using more inputs). The comparison with these units is particularly informative because one cannot invoke structural differences to explain differences in performance. The authors also develop variations around the fundamental methodology and are working, under the Aquameth 2 project, on a software package that might allow, in the near future, academic administrators, analysts and policy makers to design interactively the most appropriate input–output model and to learn from very detailed comparisons.

This volume is the result of a collective effort. One of the main goals of the PRIME Network of Excellence (NoE) is to build up integrated data

structures at the European level, overcoming institutional fragmentation and allowing new insights for policy making. The Network has been one of the best environments to test the validity of the approach and to receive comments and criticism. We thank our colleagues from PRIME for supporting what initially appeared as an excessively risky endeavour. The intellectual and social climate of the meetings helped to give thrust to the project. In addition to a large number of internal meetings, preliminary results were discussed at PRIME Annual Conferences, the 8th and 9th International Conferences on Science and Technology Indicators in Leiden (September 2004) and in Leuven (September 2006), the 3rd and 4th North American Productivity Workshops in Toronto (June 2004) and New York (June 2006), the 9th European Workshop on Efficiency and Productivity Analysis in Brussels (June 2005), the European Network of Indicator Producers (ENIP) Conference in Lisbon (September 2005), the Maastricht Economic and social Research and training centre on Innovation and Technology (MERIT) Workshop on Knowledge Indicators (October 2005), the Atlanta Conference on Science and Technology Policy (May 2006), the Institute for Prospective Technological Studies (IPTS) Workshop on Universities in Brussels (May 2006), the International Conference for the 60th Anniversary of Sciences Po in Paris (June 2006), and the OECD Blue Sky II Indicators Conference in Ottawa (September 2006) and at seminars at the universities of Genova, Liège, Manchester, Marne-la-Vallée, Paris X and Turin.

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