



Efficiency and economies of scale and specialization in European universities: A directional distance approach



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ABSTRACT

In this paper we investigate economies of scale and specialization of European universities. The proposed approach builds on the notion that university production is a multi-input multi-output process different than standard production activity. The analyses are based on an interesting database which integrates the main European universities data on inputs and outputs with bibliometric data on publications, impact and collaborations. We pursue a cross-country perspective; we include subject mix and introduce a robust modeling of production trade-offs. Finally we test the statistical significance of scale and specialization and find that they both have a significant impact on the efficiency of the Humboldt model. Nevertheless, confirming previous findings, specialization has not a significant impact on the efficiency of the research model.

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1. Introduction

This paper addresses two contested issues that are at the core of recent debates in higher education and makes the argument that, in order to address them sensibly, there is a need for the integration of existing data and for new elaboration techniques. Thus, although the ultimate issue is a policy one, the approach we suggest makes use of an integrated dataset at European level and applies new techniques.⁴ To be more precise: we argue that without an investment into data integration (including data retrieval and data cleaning) and new informetrics, these policy issues cannot be addressed appropriately.

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⁴ In Bonaccorsi, Daraio, and Simar (2013) we analyse the impact of scale and specialization on the research efficiency of European universities. In this paper we extend the analysis including additional bibliometric indicators such as Normalized Impact, High Quality Publications, Excellence Rate and International Collaborations. Moreover, we test the impact of scale and specialization by applying state of the art approaches (Daraio & Simar, 2014).

The two issues under discussion can be formulated as follows:

- (a) how does the size of universities influence their efficiency? In other terms, are there economies of scale in higher education?
- (b) is there a need to reconsider the main organizational model of universities, which is predominantly based on generalist institutions covering many disciplines? In other terms, are there economies of specialization in higher education?

These two questions come after the higher education system, in advanced countries, has reached the point of massification (i.e. enrolment rates exceeding 50% of the relevant age cohort), while the public budget has not grown correspondingly. Universities are put under pressure to use existing resources, namely staff and funding, in the most efficient way. At the same time there is an increased pressure from the research side: the expectations of society and policy makers on the contribution of research to societal problems have grown significantly, there are new entrants in scientific arena (particularly from Asia) and the competition for funding has increased sharply. This situation creates a classical issue in public policy: we have two valuable goals (serving better mass educational needs and producing good research) between which there is tension. The trade-off between the two goals would require a grounded theory of production, which can be framed in the economic language. If we assume that universities are units of production, then these issues require investigating the existence and importance of economies of scale and specialization. Do we need to increase the size of universities, in order to enhance their efficiency? Do we need to increase the specialization of universities, favoring focused institutions (e.g. technical universities, medical schools, business schools) against the more traditional generalist institutions, covering many unrelated disciplines?

The paper is organized as follows.

In the next section, the relevant literature as well as the main research questions addressed in the paper are outlined. Section 3 describes the main data used in the analysis, providing details on the integration of the different sources. Section 4 provides a simplified graphical illustration of university's activities and their trade-offs. Section 5 provides the methodological background, while Section 6 reports the main results and Section 7 concludes the paper. Appendix A describes the factorial analysis conducted on the data and provides some details on the calculation of gaps.

2. Economies of scale and specialization in higher education

2.1. General introduction

In this section we offer a short and focused survey of the literature.

Economies of scale refer to the reduction of cost per unit of output when the size of operations increases, mainly due to the reduction of unitary fixed costs, but often due also to lower variable costs.

Economies of specialization arise when the cost of producing a specific good by a specialized firm is lower than the cost of the same good made by a firm which produces together two or more goods.

Before entering into the details, let us remind that the issue of economies of scale and specialization can be addressed according to two different approaches.

The first has worked directly with cost functions as the dual of production functions. Here the main difficulty has been the modeling of a production function which is, by definition, not only multi-input (as any production function), but also multi-output. The traditional econometric techniques used to estimate economies of scale in a monoproduction setting were clearly inadequate. After the introduction of a full scale theory of the multi-product firm (Baumol, Panzar, & Willig, 1982), several appropriate econometric techniques have been introduced (see Bonaccorsi & Daraio, 2003, 2004 for an overview).

The second approach is based on the estimation of technical efficiency of the units under analysis, namely the best use of resources (inputs) to realize their outputs. In this line of research, the existence and magnitude of economies of scale and specialization is derived from the difference between the efficiency scores of observed Decision Making Units (DMUs) and the scores that would be obtained if the inputs (and/or outputs) were aggregated. In nonparametric efficiency analysis, traditionally based on a Data Envelopment Analysis (DEA) approach (see e.g. Färe, Grosskopf, & Lovell, 1994), economies of specialization are computed on the base of the comparison of the frontier of specialized firms and the frontier of multiproduct firm constructed from the sum of specialized firms. This approach, however, introduces in the analysis additional assumptions (which rely e.g. on the convexity and additional assumptions on the hypothetical firm, and the sample size bias). Recent works in efficiency analysis (see e.g. Daraio & Simar, 2007) propose the conditional nonparametric analysis to investigate the impact of scale and specialization, which are considered as external–environmental factors that are neither inputs nor outputs under the control of the DMU, but might influence the performance of the units. In this paper we follow the foregoing approach, extending the efficiency methodology to robust and conditional directional distances and implementing a recently introduced test (Daraio & Simar, 2014), based on the bootstrap, to assess the significance of scale and specialization impact.

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