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CONTENTS

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ECONOMIES OF SCALE AT FACULTIES

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Today, universities and faculties have become used to being analysed with performance or productivity measurement instruments. Methods have broadened and integrate qualitative and quantitative approaches. This research gives an overview regarding approaches to efficiency analysis in higher education. It asks how far efficiency is already a question for faculty management, includes a case study regarding faculty-based efficiency measurement for an example of 25 German economics and business administration schools and derives implications for higher education research and in particular for faculty management.

1. INTRODUCTION

Higher education efficiency has been traditionally an important research question, especially in relation to research productivity (Bottomley/Dunworth 1974; Barth/Vertinsky 1975; Banker, 1986; Ahn et al. 1988; Cohn et al. 1989; Johnes/Johnes 1993; Ramsden 1994; Beasley 1995; Dundar/Lewis 1995; Hashimoto/Cohn 1997; Glass et al. 1998; Stahl et al. 1998). But during the last 15 years, this small and usually qualitative field of analysis within universities and faculties has been broadened in terms of methods and comparative international views as well as implications for the practice of higher education management in many countries (Madden et al. 1997; Ng/Li 2000; Jongbloed/Vossensteyn 2001; Korhonen et al. 2001; Feng et al. 2004; Johnes 2006; Kocher et al. 2006; Kao/Hung 2008; Sarrico, 2010; Zangoueinezhad/Moshabaki 2011; Klumpp/Zelewski 2012).

Tight budgets impel public stakeholders as well as university leadership persons to ask for instruments for accountability – which are often interpreted as performance or productivity measurement instruments. This research gives an overview regarding approaches to efficiency analysis in higher education (sections 2 and 3), including a case study regarding faculty-based efficiency measurement for an example of 25 German economics and business administration schools (section 4). It reports on some distinguished international findings and outlines the implications for higher education research and management.

2. EFFICIENCY AS A QUESTION FOR FACULTY MANAGEMENT

The efficiency or productivity of university and faculty operations has been a discussed and reported management question (Scholz/Stein 2013) and is *complex* due to the very special nature of the university (and the faculties) as an organisational *type* and due also to the complexity of university and faculty *outputs*. Since the objective functions in higher education in the three areas of research, teaching and 'third mission' (often termed 'transfer', 'outreach', 'community services', see Zomer/Benneworth 2011, 82)

contain of a multitude of output indicators, possible productivity measurements are by definition manifold.

Nevertheless, there are specific expectations regarding the output of universities, which can be expressed through equally specific efficiency questions. Those questions are essential for university management as many decisions taken within universities address resource allocation and are therefore directly connected to production settings. Examples of such management questions linked to higher education decisions are depicted in table 1.

Table 1: Management Questions and Management Decisions Regarding Efficiency

	Management Question (*Example*)	Management Decision (*Example*)
Research	How efficient are specific research groups, institutes, faculties (compared to all groups, institutes, faculties)?	Should specific research groups and faculties receive more funding? Should specific groups receive more management support?
Teaching	How efficient are specific teaching/ study programmes (compared to other programmes)?	Should specific programmes be supported by advertising efforts or other forms of central resources? Should specific programmes be closed?
Third Mission	How efficient are specific university co-operations within the region?	Should specific university or faculty co-operations be prolonged or ended?

The *comparative* view regarding several universities (or more seldom: faculties) has been established by research publications, e.g. Beasley (1995); Dundar/Lewis (1995); Glass et al. (1998); Ng/Li (2000); Korhonen et al. (2001); Kocher et al. (2006); Kao/ Hung (2008) and Sarrico (2010). One of the latest *data collection endeavours* supporting a comparative international is the EUMIDA project supported by the European Commission, collecting for example staff, student and graduate data (Bonaccorsi et al. 2010).

3. EFFICIENCY ANALYSIS WITH THE DATA ENVELOPMENT ANALYSIS (DEA)

Methodologies used in measuring the efficiency of higher education operations have been manifold – and have interestingly many similarities to ranking endeavours in the output field. Table 2 provides a structuring overview regarding the basic categories (A to D) for performance and productivity measurement.

Table 2: Comparison of Performance and Productivity Measurement Schemes

	One-dimensional Output Measurement	Multi-dimensional Output Measurement
Simple Output Indicators (*Performance* Measurement)	(A) Simple Output Metrics, e.g. ▪ Number of graduates per university per year ▪ Number of reviewed publications per university per year ▪ Number of patents registered per university per year	(B) Complex (Combined) Output Measurement Systems, e.g. ▪ Ranking systems as e.g. ARWU, Leiden or Times Higher Education World Universities Ranking ▪ Performance-based funding systems with several indicators
Input and Output Indicator *Relation* (*Productivity* Measurement)	(C) Simple Productivity Metrics, e.g. ▪ Total teaching cost *per* graduate at one university ▪ Number of reviewed publications or citations in reviewed journals *per* Faculty head (three years) ▪ Amount of third party/industry income per Faculty head ▪ Total number of registered patents per 1 Mio. Euro (currency) university budget	(D) Complex Productivity Calculations, e.g. ▪ Stochastic frontier analysis for number of Faculty members and number of graduates and amount of third party/industry income ▪ Data envelopment analysis for university budget (input) and number of graduates, number of publications as well as number of patents (output)

The four depicted categories and their examples according to table 2 can be outlined in detail as follows:

(A) Simple one-dimensional outputs as *performance measurements* with just *one* output indicator are quite often used in higher education management and policies, e.g. for comparing universities (or departments thereof) regarding their number of graduates per year; or universities, faculties and even research groups regarding the number of publications, patent registrations or citations per year. For third mission activities, indicators such as number or turnover of spin-offs or the total number of their employees are used to measure performance on a university or faculty level.

(B) Usually, most university and even faculty ratings use a number of *output indicators* combined in relation to the specific objective of the ranking (see for example Van Vught/Ziegele 2012). For a ranking of teaching quality a combination of teacher-student-ratio, student satisfaction, international orientation and expert reputation might be used. For a research ranking a combination of industry income (third party funding), publications, citations and peer reputation might be used. The most commonly used method to calculate the overall score for such combined indicator rankings is weighted scoring systems, allocating each indicator a share out of a total of 100 per cent weighted distribution. All individual scores (with the same span of possible values e.g. from 0 to 100) are multiplied with this weighting and then added up for the total score.

(C) Simple *productivity* metrics usually operate with a relation between one output indicator (e.g. number of publications) and one input indicator (e.g. one researcher per one million Euro [currency] budget). Essential for the distinction between performance and productivity measurement (efficiency) is the inclusion of an input indicator, commonly addressed as the 'size question' (as usu-

ally performance indicators favour larger institutions or units which more easily reach higher output numbers for example in terms of graduates or publication numbers). Though the division of output numbers by input numbers is used most often, theoretically also the division of inputs by outputs is feasible and may also yield interesting insights: For example the question of what budget has been spent on average to recruit one student or graduate or achieve one publication.

(D) For the inclusion of multiple input and multiple output indicators, a number of methods are available in order to calculate a measurement result; the two most commonly used ones are *stochastic frontier analysis* (SFA) and *data envelopment analysis* (DEA):

(i) SFA: The *stochastic frontier analysis* uses a given production function in order to calculate productivity measures from the input and output data (Aigner et al. 1977; Kumbhakar/Lovell 2000). If such a production function is known this is a very feasible method, as it indicates clearly the improvement potential for all non-efficient units (Jacobs 2001; Cullinane et al. 2006; for universities see for example: Stevens 2005). But if there is no known production function for all relevant inputs and outputs this is less valuable though assumptions may be made (Coelli 1995).

(ii) DEA: The *data envelopment analysis* was proposed in 1978 and developed further as a non-parametric multi-criteria efficiency measurement method (cf. Charnes et al. 1978; Charnes et al. 1991; Seiford 1996; Pedraja-Chaparro et al. 1997; Cooper et al. 2000; Kleine 2004; Zhu/Cook 2007; Thannasoulis et al. 2008). It is commonly used in multi-dimensional output industries such as service industries (health care: Butler/Li 2005, ecological analysis: Dyckhoff/Allen 2001) and also *higher education* (i.e. McMillan/Datta 1998; Taylor/Harris 2004; McMillan/Chan 2006).

Existing *criticism* regarding the different fields of measurement usually addresses the following areas: It is acknowledged that *single* output indicators naturally cannot depict the complex task of a university, especially since they do not take into account the distinction between the objective areas of research, teaching and third mission, neglecting the *Humboldt Principle* of an assumed or desired unity of these areas within universities as a founding principle. Additionally with just one output measurement the size of the higher education institution is crucial: larger universities have a comparative advantage in this perspective (*Matthew Effect*). From these typical critical arguments it is obvious that in developing adequate measurement and comparison systems in higher education the tendency should be directed towards systems in Category D with simultaneous multiple input and multiple output measurements. The methodology options in this last field are outlined further in the next section in the form of a small case study of faculty efficiency.

4. FACULTY EFFICIENCY CASE STUDY

In order to connect a current and relevant efficiency example regarding faculty efficiency, data for 25 German faculties for economics and business administration are analysed. A data envelopment analysis (DEA) studies different Decision Making Units (DMUs), the definition of which is rather open in order to guarantee flexibility in the term's application. In order to ensure relative comparisons, different DMUs are evaluated and compared with each other, each DMU showing a specific level of managerial effort and decision-making success. Based on the latest Handelsblatt Ranking 2013 in Germany (number of professors as input and publication points for journal publications as output; Handelsblatt 2013) and the research funding data from the German DFG (competitive research funding grants from DFG as output; DFG 2013) an efficiency analysis is carried out (see table 3 below). For the seven universities in Austria and Switzerland incorporated in the Handelsblatt ranking but without data from DFG (only German – public – universities are eligible for funding) an efficiency calculation was *not* possible.

Table 3: Case Study Data Regarding Faculty Efficiency (Output-oriented, BCC Model DEA)

University	Prof.	DFG 2008-2010 in Mio. €	Publication Points 2012	Efficiency Score
Aachen RWTH	12	353.812,55 €	42	99,20%
Augsburg Uni	14	445.889,07 €	30	60,40%
Berlin ESMT	10	*0,00 €*	35	100,00%
Berlin FU	17	2.701.107,21 €	30	70,50%
Berlin TU	11	875.591,94 €	30	80,20%
Bonn Uni	31	5.033.319,83 €	25	82,10%
Darmstadt TU	9	59.266,42 €	30	97,80%
Duisburg-Essen Uni	28	850.289,71 €	36	43,20%
EBS Uni	26	*0,00 €*	42	49,40%
Frankfurt/Main Uni	27	1.486.697,92 €	70	83,70%
Frankfurt School of Finance and Man.	28	*0,00 €*	44	51,80%
Giessen Uni	6	124.494,41 €	15	100,00%
Graz Uni	*15*	*0,00 €*	34	-
Hamburg Uni	32	278.261,45 €	68	80,00%
Hannover Uni	11	843.168,76 €	26	69,80%
Innsbruck Uni	*15*	*0,00 €*	46	-
Jena Uni	10	1.430.750,02 €	33	100,00%
Kiel Uni	8	875.238,69 €	14	100,00%
Koblenz/Vallendar WHU	25	*0,00 €*	55	64,70%
Köln Uni	25	1.625.446,88 €	68	81,60%
Kühne Logistics Uni	6	*0,00 €*	18	100,00%
Magdeburg Uni	12	247.446,60 €	24	56,80%
Mannheim Uni	24	6.129.920,61 €	78	100,00%
München LMU	22	4.622.675,13 €	69	94,80%
München TU	23	746.163,98 €	85	100,00%
Münster Uni	18	756.286,40 €	33	51,50%
St.Gallen Uni	*44*	*0,00 €*	118	-
Wien Uni	*16*	*0,00 €*	91	-
Wien WU	*45*	*0,00 €*	87	-
Würzburg Uni	10	154.300,00 €	18	52,00%
Zürich ETH	*12*	*0,00 €*	63	-
Zürich Uni	*27*	*0,00 €*	89	-

5. CONCLUSION

It has to be emphasised that for management implications and decisions, *further analysis* of all efficiency measurements is needed in order to understand the complex connections regarding productivity in university operations. Detailed analytical approaches should address the interaction of research and teaching as well as other success factors for university operations such as location and regional networks, gender issues, leadership and organisational matters. From the outlined case study as well as previous research regarding university efficiency the following *implication* areas and hypotheses may be derived:

- No empirical evidence for economies of scale can be found (hypothesis not falsified but increasing probability for a diseconomies of scale hypothesis).
- Possible reasons and influences may be coordination efforts, increasing "mission diversity" and "mission creep" with institutional size.
- A positive view may see that benchmarking reveals efficiency potential in most settings and analyses – for *all* subgroups (large/small, private/public).
- The efficiency view may be a complementary and necessary (new) perspective.

For the practical *faculty management* context, some implications can be named as additional hypotheses:

- Faculties shall cease from "size matters" strategies – or use this only in very cautious applications, i.e. only with "checks and balances".
- Faculties shall rethink objectives, strategies and excellence concepts – in combination with "quality profiling", because otherwise efficiency measurement has no real meaning.
- Faculties shall make "excess costs of excellence and size" internally visible in institutions (and also provide "fair" cost allocation).
- Faculties shall make the efficiency view a *complementary* standard KPI / management question in major decisions (e.g. see research results for long-term efficiency costs of mergers, cp. Klumpp/Zelewski 2012).

According to the presented results it has become obvious that *university efficiency* is a major question that has to be addressed in research as well as in higher education university leadership concepts in order to create the modern and successful institutions that all university stakeholder are striving for.

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