

EXPLAINING OUTPUT AND INPUT MEASURES IN UNIVERSITY EFFICIENCY STUDIES

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Abstract

This paper takes a critical look at explaining outputs and inputs of university efficiency studies by adopting an extensive literature review method. An attempt was made to define efficiency in relation to university operations. University outputs were discussed in relation to teaching and research outputs. Teaching output is almost exclusively proxied by physical headcount of the full time equivalent (FTE) enrollments or number of degrees while recognizing the quality limitation that exists. The author maintained that University research are diverse and include research and includes books, journal articles, conference papers, software, patents, works of art, public lectures research grant received and the number of Ph.D degrees awarded. The study regarded capital, operating cost and input quality as a measure of input. Capital consists of land, buildings, plants and equipment, etc. Operating costs includes academic and general staff salaries and other expenses. The paper further explained that total staff number (FTE) which includes general and academic staff, administrative staff, and other academic support staff, such as research assistants, technicians and academics services, such as library and academic computing services as measure of university input. The study concluded that input and outputs of universities should be carefully selected if university efficiency is to be maximized.

Keywords: Output and Input Measures, University Efficiency Studies

Introduction

Universities produce a variety of outputs. Nearly all efficiency studies of higher education institutions focus on what Estelle James (1978) refers to as academic products of universities, the advancement and transference of knowledge. Translating these tasks into two identifiable outputs represents the standard notion of teaching and research. However, while it is straightforward to conceptualize both resist detailed characterizations. Outputs possess both tangible and intangible aspects (Hopkins and Massy (1981), cited in Salerno (2003) that are often difficult to capture empirically. Cost and production studies of higher education institutions readily acknowledge that the coefficient estimated are distorted by the difficulty in effectively accounting for input and output quality. Unfortunately, lack of consensus on the part of researchers over how to adequately account for quality and the substantial cost in both time and resources of obtaining meaningful data has left this issue largely unresolved (Salerno, 2003). When one is studying the efficiency of a manufacturing industry such as electronic factories, the definitions and measurement of these variables would be fairly identified. However, measuring university outputs and inputs is extremely difficult because they are diverse and multi-dimensional. Hence proxies are required for most university outputs and inputs in seeking to derive measure of performance. The information that is available has precluded the development of robust measures for certain outputs like professional advice and inputs such as capital (Carrington, Coelli and Rao, 2005). The primary objective of establishing a university is to produce teaching, research and services to the community. This makes a university a multi- output and multi-input organization. This study focuses on the examination of the outputs and inputs of teaching and research.

Efficiency in Higher Education Defined

The concept of efficiency relates the outcome of a process to its input. A system is said to be efficient if maximum output is obtained from a given input or if a given output is obtained with minimum input (Afolabi, 2005, Ludger and Gabriela, 2006). Efficiency therefore has to do with the ratio between outputs and inputs. There are two main aspects to an efficient resource use, first, efficiency is about allocating efficiently between different kinds of resources, for example, between teachers and classrooms or between more teachers per students and better qualified teachers, that is about choosing the most efficient input mix (allocative efficiency). Secondly efficiency is also about using each resource efficiently that is making the best use of each given input (technical efficiency). The assessment of efficiency in education has both external aspect which is an investment outside the education system, and internal aspect which refers to the internal functioning of the education system.

Moreover, Akpa (2000) opined that educational system's efficiency entails compliance with standard norms like (i) student teacher ratio, student-class ratio, progression and graduation rates, wastage rates including repetition and dropout rates (ii) accessibility criterion (iii) functional relevance of curriculum (iv) cost-effectiveness of running the system. He further noted that cost-effectiveness as a criterion for internal efficiency satisfies the combination by various inputs in order to maximize outputs by redressing unnecessary costs and wastage. It ensures optimal utilization rate of spaces, direct labour as opposed to contracting, bulk purchasing, optimum school population, maintenance culture and minimizing mushrooming of schools, temporary structures, importation and other cost-saving devices.

External efficiency refers to the quality of learning achieved by the system; an educational system may be externally inefficient if the graduates who are turned out do not meet the needs of the society, economy or higher level of education; this results in unemployment, redundancy and not meeting further education requirement. The external efficiency of an educational system involves relationship between school and world of work. Therefore to enhance socio-economic development, it is very important to train manpower that will be well equipped to handle technical and managerial positions. One of the problems in developing countries is graduate unemployment (Afolabi, 2005).

McGrath (1993) opines that efficiency is often integrated into the more popular term of accountability which measures outputs. In this context, efficiency is related to cost-benefit, cost-effectiveness and cost-utility in terms of both inputs and outputs. In higher education, Oliveira (2005) examined educational efficiency from two components. These are economic and social components. It is argued that not only the economic component (which synthesizes the cost and the yield) must be measured, but its social components (that include performance in social effectiveness and development). If the valuation of efficiency in education will be restricted to an economic analysis, it will only reflect the money used to get results, which means the aim of evaluation will be to predict the probability and the extent of financial profit (how much money will cost to get a degree and does this investment will return and how long will it take to return). In this situation, education efficiency has a similar significance to cost-effectiveness and thus, the institutions goal is to achieve aims with less money, or to solve many tasks (output) as possible with the given money (input). The social effects of efficiency can be seen from macro and micro levels. At macro level, social effects of efficiency can be evaluated by the educational level of the population, the labour market position of graduates, scientific acknowledgement of the university and their lecturers and by the change in the demand for higher education. At a micro level, it must evaluate interest in the given institution, by the number of people seeking to be admitted in and by the level of sacrifices that families and employers are set to do to achieve a higher education.

In combining these two analyses, Vamos (2003) conclude that higher education is efficient when it is successful, economical and effective at the same time. However, not only the quantitative component of the performance must be taken into consideration, but also its qualitative components. Higher education is

successful if it fulfils its objectives as well as possible. That is, if it produced graduates in an adequate number to the social demand and if the graduates by spreading their knowledge contribute as intellectuals and individuals to increase high moral values. However, the evaluation of these social effects is only possible in a latter date after graduates started to work and when they and their employers or institutions can make consideration about their experience of adaptation. Although, this evaluation is a not a common practice because it requires contact between the evaluation committee and the employers and between them and the educational institutions.

Efficiency has been defined according to McGrath (1993) by the more composite concept of accountability. The term has been linked to educational outputs, program evaluation, and resource rationalization, among others. Conceptually, efficiency refers to output in relation to inputs. In an operational sense, it means the elimination of systemic factors that cause waste in the use of resources or delay in the provision of services. Some example of systemic waste as offered by the governments that causes inefficiency in the universities include bureaucratic overlap, excessive regulations, convoluted decision-making, counterproductive intervention in university's mandate by the government and ineffective and secretive budgetary processes.

McGrath (1993) noted that the concept of efficiency has two primary dimensions. One entails an a priori dimension which is a systematic attempt to provide for effective planning, allocation and management of resources to education. The other is an a posteriori strategy that involves the measurement of benefit derived from provision of resources.

Measure of Output

There is a considerable disagreement among researchers seeking to examine the economics of higher education institutions as to what is really the best way to estimate the output of education. For example according to Salerno (2003), consider two institutions both educating the same number of students where one provides what might be called an "excellence" education, while the other provides only a "standard" education. To simply compare the two based on the number of students they teach seriously masks the effort put into educating students and in an efficiency study, the institution educating more students per lecturer will invariably be regarded as more efficient. In other words, one institution educates significantly less number of students but puts considerable effort into teaching but the other would be deemed more efficient in determining the measures of outputs, Institutions are benchmarked and not academic staff and administration because there is insufficient information on the output of academic staff and the degree of devolution of administration services to academic staff varies among universities. Moreover, many administrative tasks are intermediate outputs for teaching and research, such as administering students' admission policy and postgraduate research, scholarships, maintaining payrolls, developing quality assurance plans and so on.

Teaching Output

In measuring the output of teaching in universities it has been suggested an ideal measure is the number of students graduated with some quality weight attached to this. Salerno (2003) noted that the opportunity costs of obtaining the necessary data are simply too great for it to be feasible. This is evident in nearly all empirical studies of higher education efficiency. Education output is almost exclusively proxied by physical headcount of the full time equivalent (FTE) enrollments or number of degrees while recognizing the quality limitation that exists. Carrington et al, (2005) observed that teaching measure should reflect dimensions of the quality and quantity of services provided. This ensures that the measures capture the increased knowledge imparted to student by academics. They also observed that developing a measure for teaching quality is problematic because people have different interpretations of quality given previous education experiences, expectations and cultural backgrounds. Teaching quality covers the presentation of abstract and complex materials that is really grasped by students' communication skills, timely management of setting and marking assignments.

Moreover, teaching methods vary across disciplines. The role of student should be paid particular attention. Students are carriers of educational outputs, but are also inputs. The personal qualities of students determine how much human capital is actually absorbed during the education. The number of hours used by students studying will obviously also influence the build-up of human capital (Forsund and Kaihagen 1999).

The innate ability of students can also influence the ease with which knowledge can be imparted to the students and hence can affect the ability of academics to devote time to other activities like research. A further complication is that students are examined at a particular point in time. However, education is a cumulative process and past school experiences will to some extent influence students' ability to learn. Consequently researchers use proxies that often focus on other dimensions of teaching to gain insight into the performance of universities: (Carrington et al., 2005). They also argued that many studies focus on the quality of teaching that the students received to gain insight into university performance. The studies often recognize that certain students require more resources to teach them than others: For example postgraduate students can require more resources than undergraduate students. And students studying science are often more resource intensive than students studying other disciplines. This separate output measures are developed for postgraduate and certain undergraduate students. The measures included students' number, enrollment and full time equivalent enrollment of students (de Groot, McMahon and Volkwein, 1991; McMillan and Datta, 1998; Ahn, Charnes and Cooper, 1988; Johnes, 1997 and Abbott and Doucouliagos, 2003).

In justifying the use of students load as a measure of teaching output, Agasisti and Johnes (2006) argued that data on student load refer to the total number of students rather than full time equivalent or to number of graduates. They further maintained that the latter measure might be deemed desirable if the primary concern is the outputs of universities, and if one is inclined to a credentialist view of education. However, it is the number of students being educated that influences costs, and a human capital theory suggests that there is tangible output embodied in those students who learn while at university but who fail to complete their course.

The Australian Bureau of Statistics (ABS) has developed a measure for university teaching for national account by using Higher Education Contribution Scheme (HECS) fees to weigh the full time equivalent student enrollment in various disciplines (ABS, 2001). However HECS fees differ from resource use or cost weights because the fees reflect the Commonwealth's desire to capture some of the benefit provided by degrees such as Medicine and Law. Weighting student loads by relative teaching cost for particular disciplines and type of students according to Carrington et al (2005) is arguably a more comprehensive measure of teaching outputs. The Weighted Equivalent Full Time Student Unit (WEFTSU) load is used to check whether the Equivalent Full Time Students Unit (EFTSU) based teaching measures are adequately capturing differences in teaching cost. The weighting for students' type and courses were developed by the Commonwealth Department of Education, Science and training (DEST). The WEFTSU is divided into research postgraduate students and other students, to check whether it adequately captures the different cost of teaching these students. But DEST did not provide information to enable one to divide a total WEFTSU into science students and non -science students (Carrington et al, 2005).

Madden, Savage and Kemp (1997) used number of graduating students (as opposed to enrolled students) as a measure of teaching output. This measure is not a perfect measure of output because it measures the number of students who actually leave with completed degrees, and it would expose universities that have poor teaching quality, which may result in poor graduation rates. However, the measure also suggests that those students who leave before completion have received no teaching services (nor gained any knowledge) which is not correct. It would also expose the less prestigious universities who accept students with lower entry scores, and hence may be less likely to complete a degree. In the same vein, universities, under pressure to get students through the system may lower their requirement; therefore the

number of graduating students from the point of view of Carrington et al is not a valid measure of teaching output

Nelson (2002) noted that the Commonwealth Government and university administrators in Australia placed great premium on measuring students' satisfaction by designing an instrument called "Course Experience Questionnaire" (CEQ) to measure teaching quality. Only graduating students are allowed to complete the questionnaire. The CEQ collects students' responses on five aspect of teaching: good teaching, clear goals and standards, appropriate workload, appropriate assessment and **generic** skills. There is also a question on the overall satisfaction with courses. He also reported that researchers have criticized the CEQ as a measure of teaching quality because they argued that most university students are excluded from the CEQ and students' notions of teaching quality are likely to vary between disciplines and between universities. For instance, science students in one university may accord a particular quality of teaching, certain score; whereas science students in another university may give the same quality of teaching a different score.

Furthermore, most students have different learning experiences in different universities, to enable them make comparative judgment about teaching quality in the same subjects. Carrington et al (2005) also asserted that the average starting salary of graduates and the percentage of students that have a job by graduation have several limitations as a measure of teaching output. The employment and salary of graduates largely depend on economic factors such as industry, productivity, company profit, and location of employment and unemployment rates. Moreover, student staying off campus are often already employed. Finally prevailing employment and salary condition are not necessarily related to the knowledge imparted to students by universities. For example, if graduates from a university with lower academic entry standard obtain similar employment rates and salaries compared to graduates from a university that has higher entry standard, they opined that these measures potentially understate the additional value of teaching provided to students in university with less challenging entry standards. In a study carried out in Nigerian Universities Oyeniran (2010) used number of students disaggregated into number of undergraduates and postgraduates as a proxy for teaching outputs in Nigerian universities.

Research Output

University research output is diverse. It includes books, journal articles, conference papers, software, patents, works of art, public lectures etc. (Carrington et al., 2005). An ideal measure would reflect the importance and quality of research. But there are two major difficulties in developing such a measure. The first is to assess the quality of the research and the second is to formulate a method to combine the different research output. The means to estimating the value of research output of universities has proved to be a controversial topic. Not only is it necessary to capture the quantity of output, which can be quite varied and given weight, but also the quality of the work must be accounted for (Abbott and Doucouliagos, 2003). The controversies are as a result of inherent difficulties of making definite judgment on the quality of research (the merit of publishing research in different journals); and defining an appropriate set of weights to combine research output.

In Forsund and Kalhagen (1999), the quality of research could be captured by influence measures by citation indices. The extent (national and international) and type of networks of academic staff could represent quality, and also international conference participation. Where relevant the diffusion of research into practical adaptations in business could be a measure of quality. In a study of the performance of Australian Universities carried out by Abbott and Doucouliagos (2003) gave a comprehensive report of the measure of research outputs by various authors in different parts of the world such as the study carried out by De Groot et al, (1991) on American universities incorporated a measure of both research output (bibliometric) and quality (peer review). In other studies carried out by Athanassopoulos and Shale (1997) and Johnes and Johnes (1993), they assessed research quantity and quality by using weighted indexes of

research publications. Johnes and Taylor (1991) measured research output by using the conventional measure of publication and citation analysis and research incomes.

The use of citation as a measure of research quality has also been used in a number of studies in the Northern American Universities, based on the annual Social Sciences Citation Index (SSCI). According to Abbott and Doucouliagos (2003), Harris (1988) however argued that with a small number of exceptions, Australian academics tend to publish in journals that are more widely cited in SSCI- listed journal which limits the usefulness of this measure in the Australian case. An alternative to using some weighted index of publications is to use external research finance attracted by a university as a proxy for research output. Cave Hanney and Kogan (1991), and Tomkins and Green (1988) opined that, research grants reflect the market value of the research conducted and can therefore be considered as a proxy for output. Johnes and Johnes (1993), however, argued that grants are spent not only on research assistance but also on other facilities, which are inputs into production. To include grants as both output and input, it is argued (Johnes and Johnes, 1993), is to double count. Abbott and Doucouliagos (2003) used Research Quantum (RQ) as a proxy for research output. RQ is government funding of each university that is calculated according to a composite research index of the research output of the universities. The RQ in effect is the amount that the government is willing to pay the universities for the research they produce. While it is not a perfect measure of research output, it is the best that is available for Australian universities they noted. The composite index is calculated from a mix of the National Competitive Grants Index, public sector research funding, research and scholarly publications and higher degree research completion and the number of competitive grants and industrial funding received. The National Competitive Grant Index is determined by the Australian Department of Employment, Education, Training and Youth Affairs (DEETYA) and weights publications according to their type (Abbott and Doucouliagos, 2003).

Another proxy for research output is research income spent during the year. It could be argued that research income/expenditure is an input. However, much of the Australian university research income is granted on the basis of output records of universities, so there is a high degree of correlation between expenditure of research income and research output (Abbott and Doucouliagos, 2003). Fox and Melbourne (1991) found that for Australian academic economists they surveyed, a 10% increase in research grants increase research output by as much as 15%. To sum up, weighted publications are the preferred measure of research output for benchmarking exercises, given the restrictive assumption association with the RQ.

The identification of the output indicators listed above has not critically referred to quality problem associated different output indicators. Quality is a multi-dimensional phenomenon that is associated with a product or service produced by a university. An important indicator of quality as it relates to university outputs is the technical quality of the product (Coelli et al 2002). Measuring quality of the product of universities is therefore a complex problem and this is central in the discussion of the quality of university education in Nigeria among researchers and policy maker. Based on the studies reviewed above, Oyeniran (2010) used number of Ph.D degrees awarded as a measure of research output. While this is not perfect measure of research output, it is the one that is available in Nigeria.

Input Measures

Specification of higher education inputs, according to Salerno (2003) essentially face the same problems with effectively accounting for quality and effort that are evident on the output side, though there is less controversy over how they should be quantified. He maintained that different input measures exist, but instead of being substitutes for each other (i.e. research income versus publications count) as in the case of output, which input measure is used is a function of what type of efficiency is being assessed, for instance, technical efficiency estimates routinely employed physical input units while cost efficiency uses expenditure-based unit. In the case of the technical efficiency, studies tend to use a mixed bag of measures: physical units of academic labour which, in almost all circumstances are measured by full time equivalent lecturers, and

some cost-based measures of capital, such as library expenditures or physical investment expenditure (Salerho, 2003). Though in many studies, researchers have made the case that personnel's salaries can be used as a rough index of faculty quality (Dundar and Lewis 1993).

In a study carried out by Abbott and Doucouliagos (2003) on Australian universities efficiency, they used the total number of academic staff (full time equivalent). They argued that most academics undertake teaching and research activities. They also used the number of non-academic staff (full time equivalent). This is because non-academic staff administers students, teaching and research process. That is, academic and non-academic staffs are joint input. The non-academic category includes general and administrative staff, buildings and grounds and student services, as well as delivery support staff. The third input they used is the expenditure on all other inputs other than labour inputs. This includes expenditure on energy, non-salary academic and administrative services. The last input is the value of non-current assets. This is a rough proxy for university capital stock.

In another study of the efficiency of Australian universities carried out by Carrington *et al* (2005), they regarded capital, operating cost and input quality as a measure of input. Capital consists of land, buildings, plants and equipment, etc. Operating costs includes academic and general staff salaries and other expenses. In a similar study by Coelli (1996), he used total staff number (FTE) which includes general and academic staff, administrative staff, non-staff expenses and other expenses include academic support staff, such as research assistants, technicians and academics services, such as library and academic computing services as measure of university input. Ahn, Charnes and Cooper (1998) examined the efficiency of American universities. As a proxy for university inputs they used number of full Professors, number of Associate Professors, number of Assistant Professors, money spent annually on maintenance and on library activities. In a study of the efficiency of Nigerian Universities, Oyeniran (2010) used total number of academic and non-academic staff and academic and non academic expenses as input measures in various models formulated.

Conclusion

This paper concludes on the notes that university is a complex organization that is involved in the transformation of inputs into outputs. This implies that universities are multi-product institutions, that is, they utilized multiple inputs to produced multiple outputs.

Recommendation

Based on the conclusion of this paper, it therefore means that inputs must be carefully selected to produce outputs of higher quality. This is the only way university efficiency can be enhanced.

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