A means of assessing the wastage of efficiency in undergraduate education

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Abstract

The aim of this paper is to propose an indicator that measures the wastage of efficiency in the undergraduate university educational process. Taking as a starting point the indicator proposed by Rao and Tikkiwal (1966), and its recent version in Ortiz (2003), a modification of this indicator is suggested to make it fully operative in the context of undergraduate education. The Rao-Tikkiwal indicator estimates the total wastage of efficiency at two levels: the wastage of internal efficiency, which takes into account the proportion of students who complete the programme (course or cycle) and the time spent in the course; and the wastage of external efficiency, which measures the validity of the learning and skills acquired during the programme (course or cycle) through the graduate students' ability to successfully enter the next level of training or the labour market. When this indicator is used to measure external efficiency, the loss of efficiency observed is less, the greater the time lapse between a given cohort and the analysis. When applied to the case of undergraduate education, given a single output (graduates), the greater the time lapse, the greater the probability that the graduate will have found employment suited to his training. However, efficiency levels should vary depending on when the individual graduate finds employment. In other words, the degree of efficiency in the case of a cohort of graduates who find employment within one year after graduation should not be equal to that of a cohort that takes longer to do so. In order to overcome this limitation, this paper presents a solution to the problem of assessing the effect of time lapse on external efficiency by proposing an indicator that takes this into account.

Keywords: education, efficiency, internal and external efficiency, wastage of efficiency.

1 Introduction

In recent years efficiency in higher education has become a crucial issue in the European Union (EU), since higher education is considered to be the key to economic development in the new century. In order to achieve this goal in the EU, two important aspects must be considered: the primarily public character of higher education, and the constraints that public deficit and debt have been subjected to in last two decades, even before the 2008 financial crisis.

According to the OECD (2005) private financing of higher education in the EU ranges between 10%-20% in most of the Member States. Poland and the United Kingdom with 30%, along with Spain, the Netherlands and Italy with around 25% private funding are at one end of the spectrum. At the other end, we find Denmark, Finland, and Greece with less than 4%. In other developed countries the situation is quite different, ranging from more than 50% in Australia, the United States and Japan to over 80% in South Korea. This evident public orientation means that higher education in Europe is strongly dependent on public resources; therefore, how these are managed is fundamental for its evolution.

In the last few decades, developed countries have suffered the scourge of public deficit; its exorbitant volume has become a burden that has hindered sustained economic growth. In the nineties, awareness of this problem led governments to adopt decisive policies and supranational agreements designed not only to check the growing deficit, but also to significantly reduce it. The Treaty on European Union (TEU) incorporated a new article condemning an excessive deficit in Member States. To enforce this, disciplinary measures were imposed in order to discourage excessive deficit, that is, a deficit that exceeds the limits set by the protocol on procedures which apply in the case of an excessive deficit (3% for public deficit/GDP ratio). The desire to reinforce the commitment of Member States to this new approach to the budget led to the adoption of the Stability and Growth Pact (SGP), which includes points on reinforcing the supervision of the budget, supervising and condemning economic policy and the acceleration and clarification of procedures pertaining to excessive deficit. The developments that have taken place since the approval of the TEU to the present moment exemplify the unequivocal desire to effectively restrict the deficit, while avoiding regulations which do not, in practice, succeed in preventing the budget deficit. Existing measures for cases of excessive deficit are oriented to this end and impose restrictions in some cases, while in others a recommendation is deemed sufficient. What has driven Europe towards this situation is not entirely new, since in previous decades the United States had also experienced a similar move that sought to incorporate into the country's constitution an amendment to the federal government's budget laws prohibiting the public deficit.

2 The importance of efficiency in higher education in Europe

In Europe efficiency in higher education has evolved from being important to playing a fundamental role once Europe adopted the objective of designing a *Europe of Knowledge* where higher education becomes a strategic element in gaining a competitive edge for economies in the 21st century; at the same time, this would allow social and economic standards obtained in the last century to continue and improve. In March 2000 the European Council formally set the goal for the EU to become *"the most competitive and dynamic knowledge-based economy in the world, capable of sustaining economic growth with more and better jobs and greater social cohesion"*[1] by 2010. The same idea was ratified in 2001 Lisbon European Council.

As a result of the conference on *The Role of Universities in the Europe of Knowledge* three objectives were agreed on in order for universities to be able to play the role assigned to them in the creation of a *Europe of Knowledge*. These three objectives were summarised by the European Commission (2003):

- Ensure that European universities have sufficient resources and that these resources are not only sustainable, but also used efficiently.
- Consolidate excellence in education and research, in particular through teamwork.
- Intensify the process of opening the university to the outside world and make it increasingly attractive to foreign applicants.

In its 2004 report on the financing of higher education the European Research Associates recognises increasing efficiency as one of the five objectives that the new measures adopted in the Members must try to achieve. These targets are, namely: increase absolute levels of funding, diversify the sources of revenue at the university's disposal, provide additional funds to guarantee excellence in research and education and increase its appeal abroad, increase the amount of financial assistance provided to students, and, as mentioned, increase efficiency.

As a result of the implementation of the University Organic Law[2] (LOU, "Ley Orgánica de Universidades"), along with the fact that Spain has adapted to the criteria stipulated by the European Higher Education Area, Spanish national authorities have reconsidered the model for

[1] European Commission (2003), p. 2.

[2] Spanish institutions of higher education have developed under three main national laws: the 1970 General Law on Education – Law 14/1970- (LGE, "Ley General de Educación"), the 1983 University Reform Law – Organic Law 11/1983- (LRU, "Ley de Reforma Universitaria"), and the 2001 Organic Law of Universities – Organic Law 6/2001- (LOU, "Ley Orgánica de Universidades"), modified by the Organic Law 4/2007

financing higher education in effect insufficient, if Spain intends to respond successfully to the challenges posed by the Europe of Knowledge in the 21st century. For this reason, the Council for University Coordination (CCU, "Consejo de Coordinación Universitaria") of the Ministry of Education created a commission on university financing to revise the financing mechanisms of the public university, identify main problems, and find solutions. The goal was to create a framework that ensures financial sufficiency, efficiency, effectiveness and equity within the public university system and promotes a means of accounting for and evaluating activities. In April 2007 the commission published a report, CCU (2007), dealing with these issues. The report acknowledges that Spain seeks to move towards the national models operating in other countries of the EU (Denmark, Finland, the Netherlands, Sweden and United Kingdom) with which Spain shares a common social model but where university standards are higher. In the countries that serve as a model for Spain to follow, higher education is granted greater social recognition both in terms of the professional qualifications it provides, as well as the role it plays in defining strategies for obtaining comparative advantages which are adopted by the national economy. Consequently, there is a greater disposition to make fiscal sacrifices that favour higher education. The percentage of GDP spent on higher education in these five countries in 2003 was, on average, 1.84%, while in Spain this was barely 1%, and the average cost per university student, adjusted for purchasing power, was 21,000 U.S. dollars, while in Spain this was close to 9,000. Moreover, the universities in these countries are strongly committed to obtaining useful results for society, a concept otherwise known as accountability. Universities have experienced significant changes since the 90s and the trend has been towards more executive governing bodies that have become not only more autonomous, but also more professional and accountable to society for their actions and performance. Trying to follow this path, the report clearly reveals that financing in Spain is insufficient to achieve European standards, but also the intention of Spanish authorities to shift towards a financing model closer to the market, where the outcomes will condition the funding of universities, and the importance of inputs will decline in favour of outputs, so of efficiency.

These goals for higher education must overcome an additional obstacle: the contractive fiscal scenario, which also affects higher education. Reducing public deficit in the short-term and debt in the long-term involves: decreasing the interest rate paid on debt, and/or reducing public expenditure, and/or increasing tax rates, and/or a more efficient management in public expenditure. Decreasing the interest rate paid on debt is not possible in Eurozone countries because they have lost control over the money supply. Moreover, interest rates in the current market are already low; therefore, the reduction would also be, in effect, quite low and, consequently, the impact on public deficit would be negligible. Checking expenditure is not

truly feasible. In Europe the demand for public and social services is constantly increasing, the minimum level of consumption is on the rise and the population is growing older, and society, which is very sensitive to the demand for redistribution, expects social benefits to continue to rise. Increasing tax rates is difficult to implement in the long-term for several reasons: firstly, from a sociological perspective, considering how unpopular tax increases are, the majority of politicians promise tax cuts or moratoriums on fiscal pressure during their election campaigns, and secondly, from an economic standpoint, supply economists are convinced that excessive tax burden discourages employment, saving, investment and risk-taking, thereby reducing production and income. The fourth option contributes to reaching the targets set and does receive popular support; this involves streamlining public expenditure, or, in other words, releasing financial resources through more efficient management of public funds. The problem lies in the fact that efficient management is as difficult to define as it is to implement.

Given that higher education in Europe is primary public, its dependence on public expenditure for its future development is undeniable, and given that this grows more than the tax revenue that finances it, but less than social demands, efficient management of public spending, including that spent on higher education, becomes the key to guaranteeing the viability of the Welfare State, as it is understood by society. In consequence, efforts must be made to develop tools that help to detect and explain inefficiency in higher education and to improve the university educational process through efficient educational policies.

3 The original indicator

In 1966 G. N. Rao and B. D. Tikkiwal propose an indicator to assess technical efficiency in courses, programmes and degrees offered by educational institutions based on the estimate of the wastage of efficiency during and after the educational process which is considered to focus on the production of a single output: the student who completes the programme under examination. The most important difficulty in elaborating this indicator is that it requires having access to very specific data about the cohorts, which are understood to be the group of students that begin the programme of study to be analysed at the same time. Needless to say, the analysis must be carried out once students have completed the programme.

According to the Rao-Tikkiwal indicator, the efficiency of a programme, course or degree would be inversely proportional to the wastage of efficiency incurred; wastages may take place during the period of study (wastage of internal or primary efficiency) or afterwards (loss of external or secondary efficiency). *Internal efficiency* would be the measure of the proportion of students who complete the coursework and the time it takes to do so. *External efficiency*

would be derived from the evidence that the skills and knowledge acquired as a result of their education and training serve to enter the labour market and obtain a position in line with their educational background, or serve as a springboard to higher levels of education. *Wastage of internal efficiency* is due to desertions during the period of study, which refers to students who leave before completing the programme, and stagnation, which is produced when students take longer to complete their studies than the period of time stipulated. *Wastage of external efficiency* refers to the extent to which graduates are not able to embark on postgraduate study or are unable to join the profession their training has prepared them for.

Rao and Tikkiwal define[3] the measures of the different types of wastage as follows:

$$W_d = \frac{U_1}{U}$$

$$W_s = \frac{U_2}{U}$$

$$W_{fs} = W_d + W_s$$

$$W_{ss} = \frac{U_3}{U}$$

$$W_t = W_{fs} + W_{ss}$$

Where:

W_d = measure of wastage due to dropouts.

W = measure of wastage due to stagnation.

W_{fs} = measure of wastage at the first stage (internal inefficiency).

W_{ss} = measure of wastage at the second stage (external inefficiency).

W_t = measure of total efficiency wastage.

$U_1 = \sum_{i=1}^{k} iN_{3i}$ =

Total number of years spent by the members, out of *N*, who drop out of the course up to the period *k*.

$U_2 = \sum_{i=1}^{k-d} iN_{2i}$ =

Total number of additional years spent in the course by delayed successful members.

[3] It is important to note that in these definitions the terms course, programme or degree are used as synonyms depending on the context in question.

$U_3 = M \times d$

$U = d\,(N_1+N_2) + \sum_{i=1}^{k} i(N_{2i} + N_{3i}) =$

Total number of years spent in the course by the N members of the cohort, where each N member is observed for a period k ($\geq d$) and where $N_{2i} = 0$ for k-$d < i \leq k$.

d = minimum duration (years) for finishing studies.

k ($\geq d$) = date of analysis.

N_1 = number of members of the cohort who complete the course in d years.

N_{2i} = number of members who complete the course in $d+i$ years, where i = 1,2...k-d

$N_2 = \sum_{i=1}^{k-d} N_{2i} =$

Number of members who complete the course in $d+i$ years, for all $i \geq 1$.

N_{3i} = number of members who drop out of the course after spending i years in it, where i = 1, 2, ..., k.

$N_3 = \sum_{i=1}^{k} N_{3i} =$

Total number of members who drop out of the course without completing it.

M = number of members, out of (N_1+N_2), who are unable to join the profession requiring the course or to study postgraduate studies.

$N = N_1 + N_2 + N_3 =$

Number of members in the cohort.

The population of N members will be classified into the following (2k-d+1) mutually exclusive classes.

C_1 = those members who complete the course in exactly d years.

C_{2i} = members who complete the course in $d+i$ years, where i = 1,2,...,k-d.

C_{3i} = those members who drop out of the course after spending i years in the course, where i = 1, 2, ..., k.

The size of each class would be:

N_1 for C_1.

N_{2i} (i = 1, 2, ..., k-d) for C_{2i}.

N_{3i} (i = 1, 2, ..., k) for C_{3i}.

The authors indicate and demonstrate that the measures of efficiency wastage (W) should satisfy three criteria:

$$W_d = \frac{U_1}{U}$$

$$W_s = \frac{U_2}{U}$$

$$W_{fs} = W_d + W_s$$

$$W_{ss} = \frac{U_3}{U}$$

$$W_t = W_{fs} + W_{ss}$$

1) They must be Non-negative, Additive, and adopt Values between 0 and 1.

   All W are non-negative and additive by definition. The following inequality relations easily show that all wastage measures lie between 0 and 1.

   $$0 \le U_1 \le U$$

   $$0 \le U_2 < U$$

   $$0 \le U_3 \le U$$

   $$0 \le U_1 + U_2 \le U$$

   $$0 \le U_1 + U_2 + U_3 \le U$$

2) They must be based on the number of years spent in the course, but remain independent of the particular type of wastage measured.

   The very definition of W demonstrates its independence from the unit of measurement used to measure the periods of time.

3) They must be statistically relevant.

   Tikkiwal and Tikkiwal (2000) demonstrate that the measures proposed yield statistically significant results.

4 The modification

Ortiz (2003) applied this mean to measure efficiency in three engineering degrees in the *Universidad Nacional del Sur* (Argentina), but applied a revision of the original indicator: the high stagnation detected in the analysed degrees made her consider a new category of students, those that were still registered at the time of the study.

In various countries students frequently take significantly longer to complete certain degree programmes than what is theoretically stipulated. This implies not only an inefficient use of both human and material resources and, consequently, economic, but in terms of our analysis

leads to the existence of members of the cohort who are still in the programme at the same time as the analysis is being carried out. This situation may be due to several factors: the fact that the teaching staff do not carry out their functions properly, or that the programme and curriculum are poorly designed, or that the students admitted into the programme should not have been. The explanation is usually a complex combination of the three.

It seems clear that this aspect becomes more relevant the closer the cohort is to the point in time when the study is begun. It will become even more important the more up-to-date the study aims to be and will require the introduction of a new category of students, in addition to the members who drop out of the course and students who complete the course within the expected time frame. This new category includes students who are still in the programme at the time the analysis is begun. This group would be included as part of the total number of students whose progress is characterised as stagnant, along with those who take longer to complete the course than the expected number of years.

Ortiz (2003) suggests the following **reformulation**:

$$W_d = \frac{U_1}{U}$$

$$W_s = \frac{U_2 + U_4}{U}$$

$$W_{fs} = W_d + W_s$$

$$W_{ss} = \frac{U_3}{U}$$

$$W_t = W_{fs} + W_{ss}$$

Where:

W_d = measure of wastage due to dropouts.

W_s = measure of wastage due to stagnation.

W_{fs} = measure of wastage at the first stage (internal inefficiency).

W_{ss} = measure of wastage at the second stage (external inefficiency).

W_t = measure of total efficiency wastage.

$$U_1 = \sum_{i=1}^{k} iN_{3i} =$$

Total number of years spent by the members, out of *N*, who drop out of the course up to the period *k*.

$$U_2 = \sum_{i=1}^{k-d} iN_{2i} =$$

Total number of additional years spent in the course by delayed successful members.

$U_3 = M \times d$

$\boldsymbol{U_4} = k \times N_4 =$

Total number of years spent in the course by members who are still in the course in $k \geq d$.

$\boldsymbol{U} = k \times N_4 + d\,(N_1+N_2) + \sum_{i=1}^{k} i(N_{2i} + N_{3i}) =$

The total number of years spent in the course by the N members of the cohort, where each N member is observed for a period k ($\geq d$) and where $N_{2i} = 0$ for k-$d < i \leq k$.

d = minimum duration (years) for finishing studies.

$k\ (\geq d)$ = date of analysis.

N_1 = number of members of the cohort who complete the course in d years.

N_{2i} = number of members who complete the course in $d+i$ years, where i = 1,2...k-d

$N_2 = \sum_{i=1}^{k-d} N_{2i} =$

Number of members who complete the course in $d+i$ years, for all $i \geq 1$.

N_{3i} = number of members who drop out of the course after spending i years in it, where i = 1, 2, ..., k.

$N_3 = \sum_{i=1}^{k} N_{3i} =$

Total number of members who drop out of the course without completing it.

$\boldsymbol{N_4}$ = number of members who are still in the course in $k \geq d$.

M = number of members, out of (N_1+N_2), who are unable to join the profession requiring the course or to study postgraduate studies.

$\boldsymbol{N} = N_1 + N_2 + N_3 + N_4 =$

Number of members in the cohort.

5 The suggested indicator

After analysing the original indicator the following is deduced: the loss of external efficiency is less, the greater the time elapsed between a given cohort and the analysis. The greater the time lapse, the greater the probability that the graduate will have found employment suited to his training. Following the original approach, when analysing a cohort that began a

four year course (d = 4), in 1995, for example, by 2004 (k = 10), graduates will have had a period of six years ($k - d$) during which no loss in external efficiency may be observed. If, at the same time, an analysis of the 1996 cohort is carried out, graduates will have had only five years to display no loss in external efficiency. Therefore, comparisons between the two would not be accurate.

Consequently, when observing the evolution of external efficiency in the case of a particular programme over time, assuming its capacity to place graduates in the job market remains the same, and following the original formula, the index used will generate more positive values for the cohorts when the time elapsed between graduation and the time of the analysis is greater. In other words, in terms of external efficiency, the same value for two different cohorts may have a different interpretation, and one interpretation may be less favourable in the case of cohorts where the time lapse between graduation and the analysis is less.

This discrepancy can be resolved simply by reformulating M. In the original formula M refers to the number of graduates who had not been able to join the profession suited to the training provided by the course, or had not gone on to postgraduate study at the time of the case study. This value was then multiplied by d, the theoretical duration of the course, in order to obtain U_3. It would suffice to redefine M as M^* which would measure the course's incapacity to place graduates in jobs suited to their training, or in post graduate study, in terms of the number of graduates in this situation. There are many options for finding specific values for M^*. However, it is important that this measure not be conditioned by the particular moment when the analysis is carried out. The focus must be on determining how long it takes the student to enter the job market or begin post graduate study after completing the course. If national or regional data on the average period of time it takes students who have completed the same course to enter the labour market were available, one option would be to include as M^* the students who have taken longer to do so. Another option would be to make this more flexible by setting a maximum number of years after graduation during which time they should,

theoretically, be able to find suitable employment (this value could equal the national or regional average of those who have completed the same degree). It should be understood that after this theoretical period of time, employment would be a result of other factors, apart from the training received during the course (for example, training courses offered by public unemployment offices). This would allow us to assign different values to inefficiency, depending on whether the graduate finds employment before the end of the first year (inefficiency = 0), by the end of the second, the third, or later than the theoretical maximum. In the last case, inefficiency would be greatest, equalling 1.

The **new equation** for the Rao-Tikkiwal indicator (with Ortiz's modification) could be:

$$W_d = \frac{U_1}{U}$$

$$W_s = \frac{U_2 + U_4}{U}$$

$$W_{fs} = W_d + W_s$$

$$W_{ss} = \frac{U_3}{U}$$

$$W_t = W_{fs} + W_{ss}$$

Where:

W_d = measure of wastage due to dropouts.

W_s = measure of wastage due to stagnation.

W_{fs} = measure of wastage at the first stage (internal inefficiency).

W_{ss} = measure of wastage at the second stage (external inefficiency).

W_t = measure of total efficiency wastage.

$$U_1 = \sum_{i=1}^{k} iN_{3i} =$$

Total number of years spent by the members, out of *N*, who drop out of the course up to the period *k*.

$$U_2 = \sum_{i=1}^{k-d} iN_{2i} =$$

Total number of additional years spent in the course by delayed successful members.

$$U_3 = \boldsymbol{M^*} \times d$$

$U_4 = k \times N_4 =$

Total number of years spent in the course by members who are still in the course in $k \geq d$.

$$U = k \times N_4 + d\,(N_1+N_2) + \sum_{i=1}^{k} i(N_{2i} + N_{3i}) =$$

The total number of years spent in the course by the N members of the cohort, where each N member is observed for a period k ($\geq d$) and where $N_{2i} = 0$ for k-d $< i \leq k$.

d = minimum duration (years) for finishing studies.

k ($\geq d$) = date of analysis.

N_1 = number of members of the cohort who complete the course in d years.

N_{2i} = number of members who complete the course in $d+i$ years, where i = 1,2...k-d

$$N_2 = \sum_{i=1}^{k-d} N_{2i} =$$

Number of members who complete the course in $d+i$ years, for all $i \geq 1$.

N_{3i} = number of members who drop out of the course after spending i years in it, where i = 1, 2, ..., k.

$$N_3 = \sum_{i=1}^{k} N_{3i} =$$

Total number of members who drop out of the course without completing it.

N_4 = number of members who are still in the course in $k \geq d$.

$N = N_1 + N_2 + N_3 + N_4 =$

Number of members in the course.

$$\boldsymbol{M^*} = \sum_{j=1}^{N_1+N_2} m_j^* =$$

This measure is expressed in terms of the number of graduates that fall in this category and refers to the incapacity of the course to either place graduates in employment suited to the training provided on the course or in graduate study.

$$\boldsymbol{m_j^*} = \begin{cases} \dfrac{TE_j - TG_j - 1}{AT} & if \ \left(TE_j - TG_j\right) < AT \\ 1 \ if \ \left(TE_j - TG_j\right) \geq AT \end{cases}$$

This measures the incapacity of the course to place graduate j in employment suited to his training or in graduate study, where j = 1, 2, ..., N_1+N_2.

TE_j = period of time, starting with the first year, that graduate *j* takes to find employment suited to his training (provided in the course) or to begin graduate study.

TG_j = period of time, starting with the first year, that graduate *j* takes to graduate.

AT = the estimated average period of time after graduation it takes the student to find employment suited to the training in the course or to begin graduate study

Obviously, weighting external efficiency using this method would be more precise if estimates were based on months rather than years, but, in practice, it is virtually impossible to obtain updated reliable data on a monthly basis, taking into account that at present even annual data are very difficult to collect.

6 Conclusions

Higher education in the EU is fundamentally public. In the current EU context there is a clear commitment to higher education as a guarantor of future economic and social progress, but there is also a clear restraint of public resources. Consequently, new means aimed at making the most of these public resources in higher education must be adopted. In order for politicians to plan suitable policies, operative tools must be designed.

The proposed inefficiency indicator is a reformulation of the modification that Ortiz presented in 2003 to the Rao and Tikkiwal indicator, which tries to make it operative in higher education institutions. Through this reformulation the time lapse problems detected can be easily solved by estimating the wastage of external efficiency in a more realistic way, thereby obtaining a more accurate measure of the wastage of total efficiency. Adopting the modification introduced by Ortiz is especially helpful when applied to Spanish higher education institutions, as these are characterised by a high stagnation.

The ongoing process of change higher education in Spain is experiencing, particularly in terms of financing, requires an effective means of evaluating the real performance of institutions and programmes, since their financing will depend on it. With the proposed indicator the technical efficiency of undergraduate programmes can be easily evaluated by measuring the wastage of internal efficiency (that takes place during the educational process) and external (after the educational process). In addition, this indicator also provides information about the weakness of the programme at every step of the process. This is very important since it means that the reasons for the wastage can be identified (wastage due to dropouts and/or to stagnation and/or to employability).

Certainly, administrations and universities must support all these means by investing more resources (human and material) in order to make the necessary information on all students involved in the system more easily available.

This is particularly important in relation to alumni for which there is no such detailed and updated information, as well as in the case of students who are still in the undergraduate programmes.

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