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Understanding Productivity Changes in Public Universities: Evidence from Spain

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Abstract

This study examines the productivity growth of Spanish universities over the period 1994-2008. The Malmquist index is used to illustrate the contribution of efficiency and technological change to changes in the universities' productivity. The results indicate that annual productivity growth is attributable largely to efficiency improvements rather than technological progress. Gains in scale efficiency appear to have played only a minor role in productivity gains. The results contribute to the knowledge of the university system in Spain, describing different university behaviours that could be useful for management at the institutional and national level.

Keywords: Public Universities; Productivity; Technical and Scale efficiency; Technological change; Malmquist index

1. Introduction

In most industrialized countries, demands for accountability and transparency have increased. The pressure on public budgets has led governments to control and pursue efficiencies and productivity in the allocation and management of public sector resources (Stella and Woodhouse, 2006). This public concern has forced government to take on responsibility for evaluation and control of publicly funded institutions, and they have started to develop evaluation systems and programmes that are proving beneficial for the design of policy to improve the effectiveness of funding.

Education institutions are of interest because education, especially higher education (HE), is one of the main sources of economic growth (World Bank, 2002; Johnes, 2008; COM, 2010). Thus, the study of the structure and dynamics of universities gains importance, as well as performance assessment that tries to guarantee an efficient use of resources, an improvement of university productivity and the promotion of an internal quality culture (Bonaccorsi et al., 2007; Cerezo et al., 2008).

Productivity in HE has an obvious multidimensional character as it relates to both the production and dissemination of knowledge, through its various activities of teaching, research, and outreach (Buela-Casal et al., 2009). Due to the central role of universities in the education and research system, both policy makers and society as a whole are interested in the results of the evaluation processes of universities. In this context, national and international rankings of universities, based on prestige indicators, as well as different structural, input and output indicators have emerged during the past years, creating competition among universities to be on the top (García-Aracil and Palomares-Montero, 2010).

Spanish universities have faced different reforms in the past years and those reforms have tried to increase the quality and efficiency of the Spanish universities. However,

the results are not always what are expected (Jiménez-Contreras et al., 2003, OECD, 2008). For instance, according to the number of papers in Thomson Scientific databases Spain improved from the 15th ranking in 1982 to 10th in 2006, however Spanish papers receive only 0.7% of world's citations, indicating a low international impact of its research in most fields (FCyD, 2011). Therefore, we consider it is interesting to study the behaviour of the university system in Spain including both input and output indicators and exploring the influence of the features on university performance. This paper tries to analyse the dynamics of change in public universities institutions focusing on how universities manage their inputs and determine competitive strategies and how these influence their productivity.

2. Description of the Higher Education in Spain

2.1 Background on the Spanish Higher Education System

The Spanish Higher Education System (HES) is comprised almost exclusively of universities. In 2011, there were 79 universities: 47 stated owned, 24 private, 6 open universities (1 public and 5 private) and 2 special public universities offering only their own post-graduate programs and non-official grades (MECyD, 2011a).

Nine of the currently existing universities were established in the sixteenth century; only six public universities and four private universities were founded between then and 1968. Before the 1970s, the HES had a 'Napoleonic' organization, and universities were regulated by laws and standards issued by the state (García-Aracil, 2007). The nineteenth century and the Industrial Revolution did not result, as in many other countries, in the flourishing of new institutions. Nevertheless, the nineteenth century was a critical point for Spanish universities; liberalism stemming from the French Revolution changed the structure of the state.

A new model emerged in the 1970s with a shift from an elite system to mass HE. An important legal reform was completed in 1983, approving the University Reform Act (*Ley de Reforma Universitaria*, LRU) introducing democratization of the internal structure of universities and a move from direct state intervention to institutional autonomy, with the goal of enhancing the quality of HE. At this stage, in 1989, two independent systems for the assessment of academic staff teaching and research activities were also set up. Assessment of teaching performance became the exclusive responsibility of each university, while assessment of research performance was to be the responsibility of the National Committee for the Assessment of Research Activity (CNEAI) (Jiménez-Contreras et al., 2003).

To reinforce the culture of assessment and quality improvement, in 1992, the Spanish Council of Universities launched an 'Experimental Programme to Evaluate the Quality of the University System' in order to assess the quality of teaching, research and management in various Spanish universities. In 1993, the European Union launched the 'European Pilot Project for Evaluating Quality in HE', aimed at testing common assessment methods in European universities. Based on the European experience and the results of the experimental programme carried out in Spain, in 1995, the Council of Universities created the National Plan for Quality Assessment of Universities (PNECU), which was followed by the University Quality Plan (PCU) in 2001 (Vidal, 2003). Although the Spanish experience in quality assessment and quality assurance has been positive (Martínez Cabrera, 2003; Duch, 2006; Duch-Brown and Vilalta, 2010), there have been concerns about the links between assessment results and the decision-making system (Pollit, 1990; Mora and Vidal, 2000; Llinàs-Audet et al., 2011).

In the first years of the new millennium, Spanish universities found themselves in a new context as a result of the legal framework (*Ley de Ordenación Universitaria*, LOU)

formulated by central government towards the end of 2001 and restructured in 2007. The legislative reform, LOU 2001, introduced a profound change in the assessment of higher education institutions (HEIs). The LOU established thresholds for accreditation of programs (recognition by official qualifications) and certification for other university activities. In 2002, the National Agency for Quality Assessment and Accreditation (ANECA) was created to encourage universities to monitor their own performance critically. However, its framework and responsibilities have still not been clarified, but it is clear that its creation represents an important change in HES regulation.

At the same time, the Spanish government is encouraging universities to determine standards to improve quality and efficiency in these institutions, largely in response to the large-scale structural reorganization of the HE sector following an agreement among all European governments to transform the HE structure (the Bologna Declaration), adaptation to the European Higher Education Area (EHEA) and incorporation of Spanish academic research in the European Research Area (ERA).

These policy initiatives combined with other market and non-market force, have affected the apparent productivity of the sector.

2.2 What (Little) We Know About Productivity in the Spanish HES

In the period 1994-2008, undergraduate and doctoral degree completions grew respectively by 21% (from 133,620 to 162,643) and 32% (from 5,266 to 6,969); external government and industry grants increased by 74% (from €219 m. to €381 m.) and 45% (from €486 m. to €708 m.); and research ISI publications increased by 189% (from 11,362 to 32,851). This growth was accompanied by increases in total expenditure of 189% (from €2,476 m. to €7,169 m.) and academic and non-academic staff numbers of respectively 40% (from 66,009 to 92,566) and 51% (from 31,951 to 48,244) (COTEC, 2008; CRUE, 1996, 2010; FCyD, 2011). It has been suggested that

the productivity of the sector has improved based on expansion of the productivity frontier, suggesting fewer (or the same volume of) resources are now needed to produce the same (or more) economic outputs. However, this may not be the case.

In a world with no inefficiencies, productivity growth, measured by productivity indices (an index of output divided by an index of total input usage), is synonymous with technical progress (or shifts in the technology boundary). However, in a world where inefficiency exists, productivity cannot be interpreted as technical change unless either there is no technical inefficiency or the technical inefficiency does not change over time (Caves et al., 1982). If these conditions do not hold, then productivity is redefined as the net effect of changes in efficiency (or movements relative to the existing frontier) and shifts in the production frontier (or technical change) (Charnes et al., 1978; Färe et al., 1994). This distinction is important from a policy viewpoint, since changes in productivity growth due to inefficiency imply different policies from those that address technical change (Worthington and Lee, 2008).

In this context, remarkably little is known about the productivity of Spanish HES, and even less about productivity levels across the sector. Almost nothing is known about whether suggestions related to productivity improvements are the result of increased efficiency, increased use of technology, or both. The purpose of this paper is to assess the productivity growth of Spanish universities taking account of changes in both efficiency and technology. While not the only study to examine efficiency and/or productivity in Spanish universities or university departments (Pina and Torres, 1995; Levin, 1998; García and Gómez, 1999; Castrodeza and Peña, 2002; Martínez Cabrera, 2003; Caballero et al., 2004; Duch, 2006; Giménez and Martínez, 2006; Hernangómez et al., 2007; Martín Rivero, 2008; Asís Díez, 2009; Agasisti and Pérez-Esparrells, 2010; Duch-Brown and Vilalta, 2010), the present study is the only one to focus exclusively

on productivity, efficiency and technological change at the university-level using readily available panel data for a 15 year period (from 1994 to 2008).

3. Methodology and data

3.1 Malmquist approach

A number of techniques have been developed and applied in the context of education in an effort to measure the productivity of HEIs. Statistical techniques have progressed from simple ratios of one output to one input, to composite ratios of productivity derived from linear programming methods (Färe et al., 1994). Changes in productivity growth can be calculated using the Malmquist productivity change index, which is a widely used methodology (Maniadakis and Thanassoulis, 2004; Johnes, 2008; Kortelainen, 2008).

Malmquist (1953) originally proposed a quantity index to measure standards of living for consumption analyses. Later, the Malmquist index and its variations found application mainly in the field of production analysis. The Malmquist index was first introduced in productivity literature by Caves et al. (1982), where it was exploited as a theoretical index based on Shephard's (1970) distance function. Nishimizu and Page (1982) used a parametric programming approach to compute the first index in an empirical context and it was further developed and popularized as an empirical index by Färe et al. (1994). They decomposed productivity change (or TFP – total factor productivity – change) into a part attributable to technological (or technical) change (TC) and technical efficiency change (TEC), in which the last component was further decomposed into pure technical efficiency change (PTEC) and scale efficiency change (SEC).

Compared to other indices, Malmquist indexes have some attractive features and properties. They do not require behavioural assumptions, such as cost minimization or

profit maximization, which makes them useful in situations where producers' objectives differ, or are unknown or not achieved. They do not require price information, which implies they can be used in situations where prices do not exist, or are distorted or have little economic meaning. They are easy to compute, as Färe et al. (1994) demonstrated using non-parametric mathematical programming models for their computation. Parametric unlike non-parametric approaches require specification of a functional form linking input to outputs and, thus, are more demanding in terms of the assumptions made (Maniadakis and Thanassoulis, 2004). Moreover, under certain conditions Malmquist indexes can be related to the superlative Törnqvist (1936) and Fisher (1922) ideal quantity indexes (Caves et al., 1982; Färe et al., 1992; Balk, 1993; Coelli and Perelman, 1999; Grifell-Tatjé and Lovell, 1999; O'Donnell and Coelli, 2003; Uri, 2003a, 2003b; Rodríguez-Álvarez et al., 2004).

When applying the Malmquist methodology to study productivity, it is necessary to construct a non-parametric envelopment frontier over the data points, such that all observed points lie on or below the production frontier. There are two analytic options: input orientation, which reduces inputs without decreasing output levels, and output orientation, which raises outputs without increasing inputs. In terms of education, universities are given a fixed quantity of resources (e.g. state financial resources, academic and non-academic loads) and asked to produce as much output as possible. Thus, we assume an output orientation.

The output-based Malmquist productivity change index *(M)* specified by Färe et al. (1994) can be formulated as:

$$M_o^{t+1,t}(y_t, x_{t,} y_{t+1,} x_{t+1}) = \left[\frac{D_o^t(y_{t+1}, x_{t+1})}{D_o^t(y_{t,} x_t)} * \frac{D_o^{t+1}(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_t, x_t)} \right]^{1/2} \quad (1)$$

where the subscript *O* indicates an output-orientation, *M* is the productivity of the most recent production point (x_{t+1}, y_{t+1}) (using period $t + 1$ technology) relative to the earlier

production point (x_t, y_t) (using period *t* technology), D_0 is the output distance function which is the reciprocal of Farrell's (1957) technical efficiency measures. The output distance function is defined on the output set *P(x)*, as:

$$D_o(x,y):\min\{\theta: (y/\theta) \in P(x)\} \quad (2)$$

where θ is the corresponding level of efficiency. The output distance function seeks the largest proportional increase in the observed output vector *y* provided that the expanded vector (y/θ) is still an element of the original output set (Grosskopf et al., 1995). If the university is fully efficient such that it is at the frontier, then $D_o(x,y)= \theta =1$; $D_o(x,y)= \theta <1$ indicates that the institution is inefficient.

An equivalent way of writing the Malmquist index is:

$$M_o^{t+1,t}(y_t, x_{t,} y_{t+1,} x_{t+1}) = \frac{D_o^{t+1}(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} \left[\frac{D_o^t(y_{t+1}, x_{t+1})}{D_o^{t+1}(y_{t+1,} x_{t+1})} * \frac{D_o^t(y_t, x_t)}{D_0^{t+1}(y_t, x_t)} \right]^{1/2} \quad (3)$$

where the first term defines changes in efficiency from period *t* to *t+1*. The second term, i.e., the geometric mean in parenthesis, indicates changes in technology, i.e., a shift in the frontier from period *t* to period *t+1*.

This paper bases evaluation on the change patterns in the four indexes, TFP, PTEC, SEC and TC. Coelli et al. (1998) discuss the linear programs necessary to calculate these indices and the DEAP 2.1 software used in this paper (Coelli, 1996). If TFP, which reflects the total productivity change situation, is bigger than 1, it means that total productivity increases from round *t* to round *t+1*, otherwise total productivity drops. If TFP is equal to 1, it means that total productivity is stable. PTEC reflects two rounds of relative production efficiency change in the technology and the scale invariable situation, to measure whether the decision-making unit's production is approaching the current round's production frontier; it is described as the catching-up or horizontal effect. If PTEC is greater than 1, it indicates that in the absence of technological

innovation and scale change, the production of the decision-making unit (DMU) is approaching the production frontier, i.e. that relative efficiency has been enhanced. SEC reflects two rounds of scale return changes to the DMU (i.e. the scale returns of the DMU are increasing, decreasing or constant); this is referred to as the scale effect. If SEC is greater than 1, it indicates an increase in scale returns. TC reflects the shift in two rounds at the production frontier, or the frontier-shift or growth effect, and measures whether this production is based on technology advancement. If TC is greater than 1, it is evidence of technology advancement, and as a result the production frontier moves forward. Further details on the interpretation of these indexes can be found in Charnes et al. (1993), Lovell (2003) and Worthington and Lee (2008).

3.2 Specification of inputs and outputs

The data used in the present study consist of annual observations of the Spanish universities over the period 1994-2008. This is the longest and most recent period for which consistent data on university inputs and outputs were collected by the MUCMET ("The University Missions and Their Complementary. New Methods of Evaluating Efficiency") project supported by the Spanish Ministry of Science and Innovation's National R&D Program (2008-2010). However, we consider only 43 public universities; this is because some universities were established in 1997 and for some universities (mainly private universities) data were not available for some of the years in the period under study.

A point to note is that the measurement and analysis of productivity change is controversial and has provoked much discussion among organizational researchers and practitioners (Cohn et al., 1989; Willms and Kerckhoff, 1995; Glass et al., 1998; Malcolm and Doucouliagos, 2001; Salerno, 2006; Bonaccorsi et al., 2007; Flegg and Allen, 2007; Johnes and Yu, 2008; García-Aracil and Palomares-Montero, 2010, 2012)

about the complexity of selecting inputs and outputs to define the production function for modelling university behaviour.

In this paper, the inputs and outputs employed follow a production approach to modelling university behaviour in the form of teaching, research and outreach (Beasly, 1995; Mar Molinero, 1996, 1997; Schmoch et al., 2010; Agasisti et al., 2012). In terms of previous work, the approach selected is most consistent with Worthington and Lee (2008), but has a conceptualization of university performance in common with Beasley (1995), Koshal and Koshal (1999), Flegg et al. (2004), Salerno (2006), Johnes (2008), Johnes and Yu (2008), Johnes and Schwarzenberger (2011) and Mamun (2012). Thus, we consider a three-output, three-input model.

On the one hand, the three categories of output are: (i) undergraduate completions (as a proxy for teaching); (ii) number of research ISI publications (as a proxy for research); and (iii) industry grants (income in euros from private contracts – as a proxy for knowledge transfer).

There selected output specification involves some limitations. First, the numbers of undergraduate awards are an obvious measure of output for any university, but this measure does not recognize differences in degree program length within or across universities. Unfortunately, the data do not allow these specific measurements. Second, the output specification ignores the efforts of non-graduate students – those who attended courses, but did not graduate (Lucas and Beresford, 2010; Attewell et al., 2012), and there no direct allowance for quality, e.g. aptitude test scores (Koshal and Koshal, 1999; Chalmers, 2008). A simple way to accomplish this is to measure the number of graduating students. Data was gathered from the annual university statistics of the Council of University Coordination (CCU) and from the annual publication of Higher Education Statistics from the National Institute of Statistics (INE). The

hypothesis is that the higher the number of graduating students the higher the quality of teaching (Madden et al., 1997).

Research is equally difficult to measure. Publication counts are widely accepted as a measure of research output (De Groot et al., 1991; Johnes and Johnes, 1993; Sinuany-Stern et al., 1994; Jonhes and Yu, 2008; Agasisti et al., 2012), but then the number of journals included is critical. Publications can be categorized as: papers in academic journals, letters in academic journals, articles in professional journals, articles in popular journals, single authored books, edited books, published official reports and contributions to edited collections. However, the inclusion of too many journals means that an article in a second-rate journal will have the same value as an article in a top-ranked journal (Johnes, 1988). Other studies use publication counts and citations, and their impact factors (Sarafoglou and Haynes, 1996; Jiménez-Contreras et al., 2003; Johnes and Yu, 2008). In the absence of a reliable and easily obtainable research output measure, we considered articles published by the Institute for Scientific Information (ISI) as an indicator of international scientific production. The data were obtained from a direct search of the "Web of Science SCI Expanded", conducted in March 2010, based on the search strategy of name of institution (the task of matching affiliations in bibliometric databases to names of institutions is easily tackled where there is only one university per city, but becomes complex – up to one month's effort – in the case of large cities and metropolitan areas). As in similar studies, and despite its well-known biases (Seglen, 1997; Costas and Bordons, 2007), this data base was chosen because of its multidisciplinary nature and the fact that it is accepted as the most representative source available for analysing the international dissemination of scientific literature (Jiménez-Contreras et al., 2003).

Finally, it is acknowledged that using research income as a proxy for output is problematic, but is more understandable for the promotion of so-called third-mission activities at universities (Ahn et al., 1988, Beasley, 1990, 1995; Flegg et al., 2004; Flegg and Allen, 2007; Johnes, 2008). However, there are some ambiguities if research grants are used as a proxy for research input (Tomkins and Green, 1988; Beasley, 1990; Sinuany-Stern et al., 1994; Athanassopoulos and Shale, 1997; Laudel, 2005; Schmoch, et al., 2010; Agastisti et al., 2012). Ahn et al. (1989) use a combined approach with state funds allocated to state HEIs as the input, and federal and private research funds as a proxy for outputs. There is no consensus, but the approach selected in this paper is most consistent with Ahn et al. (1989); we considered data on income from private contracts (under article 83 of the Spanish LOU) as an ouput. Data was collected from the biannual publication of Spanish Universities' Figures published by the Vice-Chancellors Conference of the Spanish Universities (CRUE). Again, there was no direct allowance for quality, however the argument is that more substantial research will attract more income (Worthington and Lee, 2008).

On the other hand, the inputs included in the analysis are: (i) full-time equivalent academic staff, (ii) full-time equivalent non-academic staff and (iii) total expenditure (including staff costs, running expenses for goods and services, financial expenditure, flow of funds, capital expenses, real investment, and other expenses which includes financial assets and financial liabilities). This input specification is comparable to a study of Italian universities by Bonaccorsi et al. (2006).

Nevertheless, there are limitations to the selected input specification. Number of academic staff is commonly used in the literature (Tomkins and Green, 1988; Johnes and Johnes, 1993) and includes numbers of full professors, associate professors, assistants and other teaching posts. Non-academic staff is included on the assumption

that teaching, administrative and technical duties have a negative influence on research by academic staff because they have an outcome which is a reduction in the time available for research. Therefore, higher numbers of non-academic staff mean higher expected research levels (Johnes, 1988; Arcelus and Coleman, 1997; Madden et al. 1997; Worthington and Lee, 2008). This human resources data was provided by the INE. Unfortunately, the data did not allow the separation of academic staff into teaching and research or research-only staff, nor was it possible to separate non-academic staff into teaching or research-related support services.

Total expenditure is generally regarded as an input (Ahn et al., 1988), broken down into R&D expenditure (Ahn, 1987), capital expenses (Johnes, 2008), library expenses (Rhodes and Southwick, 1986), computer services and structures (Ahn et al., 1988, 1989; Ahn and Seiford, 1993), and/or space costs (Bessent and Bessent, 1980). However, in the absence of reliable and comparable disaggregated data, we used total expenditure, information provided by the biannual publication of the CRUE.

Table 1 presents a summary of descriptive statistics for outputs and inputs across the 43 Spanish public universities by year (CCU, 2010; CRUE, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010; Web of Science, 2010; INE, several years). Sample means, standard deviations, maximum and minimum are reported.

[Table 1 around here]

It can be seen that, in 2008 the typical Spanish university awarded degrees to 3,551 undergraduates, income from private contracts summed to €12,018,750 and there was a production of 764 ISI publications. On average, these outputs were achieved with 2,153 academic staff, 1,122 non-academic staff (a ratio of one technical/administrative member staff to two academics) and €216,604,250 labour and non-labour expenditure. Highlighting changes over the sample period, the last row in Table 1 (annual

accumulated variation rate) shows that the number of undergraduate completions increased by 0.89% (from 3,107 in 1994 to 3,551 in 2008), number of ISI publications increased by 7.33% (from 264 to 764), income for private contracts research increased by 12.60% (from €2,025,720 to €12,018,750), academic staff numbers increased by 2.28% (from 1,535 to 2,153), non-academic staff increased by 2.78% (from 743 to 1,122) and average expenditure increased by 7.37% (from €74,510,160 to €216,604,250). Thus, increases in outputs were more or less matched by increases in inputs. In order to analyse this "apparent" productivity growth of Spanish universities over the period 1994-2008, Malmquist indexes are reported in the next section.

4. Results

Three primary issues are addressed in the computation of Malmquist indexes for productivity growth over the sample period. The first is the measurement of productivity growth over the period (TFP). The second is to decompose changes in productivity growth into what are referred to as a 'catching-up' effect (technical efficiency change – TEC) and a 'frontier shift' effect (technological effect – TC). The third is that the 'catching-up' effect is further decomposed to identify the main source of improvement, through either enhancements to pure technical efficiency (PTEC) or increases in scale efficiency (SEC). Table 2 presents the Malmquist index and its decompositions by year and by the average change over the period.

The last row in column 2 of Table 2 shows that, from 1994 to 2008, Spanish public universities suffered a slight decrease in TFP (average 0.998). Comparing these figures with other sectors in the Spanish economy, a study by Fernández de Guevara (2011) identifies similar partners of productivity growth over the period 2000-2008 for the agriculture, hunting and forestry (average 0.6307), health and social work (average 0.7823), education (average 0.8262), electricity, gas and water supply (average 0.8358),

wholesale and retail trade (average 0.9264), fishing (average 0.9708) and manufacturing (average 0.9888) sectors. The highest productivity growth was associated with the Spanish sectors of: mining and quarrying (average 2.2510), financial intermediation (average 1.6977), public administration and defence (average 1.2045), transport, storage and communications (average 1.1962) and construction (average 1.0245). However, unlike the findings in other studies, productivity growth appears not to be comparable to Flegg et al.'s (2004) results for British universities in the period 1980/81 to 1992/93 and Worthington and Lee's (2008) findings for Australian universities from 1998 to 2003, which suggested respectively arithmetic mean growth rates of 3.6% and 3.3%.

[Table 2 around here]

Given that productivity change is the sum of technical efficiency (TEC) and technological change (TC), the major cause of productivity improvements can be ascertained by comparing their values (see Table 2, columns 5 and 6 respectively). In our case, the overall productivity change over the period is composed of an average efficiency increase (movement towards the frontier) of 1.8% (average 1.018), and average technological fall (downward shift of the frontier) of -2.0% annually (average 0.980). One implication is that, in relative terms, the university sector is relatively efficient and that technological improvements have not been well spread across the sector. It could be speculated that the introduction of formal and permanent structures in the Spanish universities to carry out evaluation and quality assurance process together the reform introduced by the legal framework in accordance with EHEA could consider positive. Nevertheless, this increasing efficiency associated to quality challenge should be assessed and demonstrated as a real challenge for the near future.

Regarding the further decomposition of the 'catching-up' effect (movement towards the frontier), the average values of PTEC and SEC are larger than 1 (see Table

2, columns 3 and 4 respectively). One suggestion for finding the drivers of improvements in PTEC and SEC is that reforms to university management and systems have enhanced efficiency of staff work and resource use. The resource recombination has improved resource allocation efficiency (allowing university productive efficiency to improve and achieve scale effects). Nevertheless, it should be interesting to analyse whether the evaluation process of academics by the ANECA has had an important impact on this finding (Vidal, 2003).

Table 2 also shows that there were substantial improvements during the academic years 1994-1995 to 1997-1998, but that in 1998-1999 the pace of technology improvement in universities slowed with the result that TC values fell sharply (0.941). TFP also fell - to 0.974, while PTEC and SEC values remained stable at approximately 1. The drop in productivity in the succeeding academic year 1999-2000 is associated with a fall in both efficiency gains and technological improvements. In the next academic year, 2001-2002, the technology improved at such a rate (TC improved by almost 30%) that a frontier-shift effect led to a vertical improvement in total productivity. But at the same time, it seems that many universities did not adapt sufficiently to those improvements and values of PTEC and SEC remained below 1. Again, since academic year 2005-2006, universities have shown a slower pace of technology improvement, with values of TC below 1. It could be said that, in relative terms, many universities have not paid attention to technological improvements.

One suggestion is that substantial improvements occurred in the period 1994-1998 when the Spanish HE system was experiencing rapid growth (inputs and outputs increased in that period, but output growth was generally double that of inputs). However, it appears that there were some problems in 1999. At that time, on the one hand, the adaptation of Spanish HE to the EHEA and ERA was likely exerting pressure

on universities to improve efficiency, but results show that universities did not adapt well to the policy reforms (a couple of years before the new university law was implemented – LOU 2001). On the other hand, the establishment of the legislative reform (LOU) in 2001 induced an increase in TFP associated mainly with technological improvements. We can assume that the LOU 2001 pushed universities to invest in infrastructures and new equipment; however, the challenge for future research should be to address the impact of legislative reforms in the Spanish HES (Monk, 1992; McLendon et al., 2006).

Table 3 shows the Malmquist productivity index and its decomposition by university and by the average change over the period 1994-2008. More detailed information is presented in the Appendix (Tables A1–A5).

[Table 3 around here]

We can formulate some conclusions based on Table 3. First, we can speculate that total productivity is influenced mainly by TEC in Spanish public universities. In order to test this supposition, we carry out a correlation analysis (see Table 4). We observe that TFP is significantly correlated to TEC, so it can be assumed that catching-up effects contribute the most to improvement in total productivity.

[Table 4 around here]

Second, the catching-up effect is comparatively significant. With the exception of four universities located in East Spain (University of Balearic Island, University of Lerida, University of Alicante and Jaume I University), two in North Spain (University of A Corunya and Public University of Navarra) and two in the Centre (University of Alcala and University of Burgos), the values of PTEC are larger than 1. One implication is that the catching-up effect is the result of management and system reforms and the reconstruction and reallocation of resources. While management of the Spanish HES is

fairly centralized, the autonomy of Spanish public universities has been increasing along with the strategic structure and systems in HEIs.

Third, changes in SEC show that scale effects are not as significant as expected, i.e., the percentage of universities where scale efficiencies result in improvements is very small. During the year 1994-1995, 15 universities showed decreased scale efficiency (35%), in 6 universities scale efficiency was stable (14%) and 22 universities showed increasing scale efficiency (51%) (see Table A4). This tendency is mostly maintained throughout the longitudinal analysis except for the 2001-2002 academic year where values of SEC dropped quite sharply, and the academic year 2002-2003 where they fell even further (70% of universities show decreasing scale efficiency, 23% of universities show stable scale efficiency and only 7% show increased scale efficiency). Table 4 shows also that the values for PTEC and SEC are negatively correlated. Therefore, technical efficiency is based mainly on improved management practices (pure technical efficiency) rather than achievement of optimal size (scale efficiency). It seems that many universities have dispersed campuses. If Spanish public universities do not adjust their methods of resource allocation and shares, they will find it difficult to increase efficiency. In other words, many universities have increased their scale without achieving greater efficiency.

Fourth, in relation to the frontier-shift effect, the values of TC are smaller than 1 in most cases, the exceptions being three technical universities (the top ranked for technological advancement): Technical University of Valencia, Technical University of Madrid and Technical University of Catalonia. The main reason for their high ranking for technological change could be that these universities improved their technology rapidly based on the number of new technologies introduced, allowing them to attract research talent and introduce innovations and reforms (FCyD, 2011).

5. Conclusions

This study examined the productivity growth of Spanish universities over the period 1994-2008. The outputs included in the analysis are undergraduate completions, number of research ISI publications and industry grants; inputs include full-time equivalent academic and non-academic staff, and total expenditure. Applying the Malmquist indexes, we decomposed productivity growth into technical efficiency and technological change.

The main findings of this study could be useful for policy; they also provide some general evidence. The results indicate that overall annual productivity growth was attributable largely to efficiency improvements rather than to technological progress. Gains in scale efficiency appear to have played only a minor role in productivity gains. The fact that technical efficiency contributes more than technological progress suggests that most universities are not operating near the best-practice frontier. Although the management of universities has changed considerably during the period analysed in this paper (universities have gradually begun implementing strategic management and planning systems and have taken steps to improve quality), it seems that some of the gains made by universities in the provision of electronic library services and learning materials, online student management systems, the provision of distance, online and multi-campus delivery, etc., are not well dispersed across the Spanish HES. Given these results, further gains will have to rely on technical innovations. This is a worrying finding since it suggests that while universities have attempted to respond to the Spanish government's call for better management of resources, they are failing to update their technology (wrong scale of operation).

Nevertheless, there are some structural differences in the system that are difficult to capture in this type of study. For instance, some universities offer a high proportion of

three year bachelor programs (mainly technical universities), while some programs are longer (mainly generalist universities), etc. These features are important for the interpretation of results – shorter time degrees are one reason why universities can produce so many graduates relatively cheaply. In addition there are some European Union level supra-national policies that influence the performance of Spanish HEIs. The new bachelor/master curricular structure is being progressively implemented in the Spanish HES, which involves only four-year/five-year courses; therefore the number of degrees awarded will decrease under the new scheme. Future research should address these themes more specifically.

The heterogeneity of HEIs also might explain efficiency differentials. For instance, size of universities, composition of staff, and subject mix are all important elements determining HEI performance. Unfortunately, the data are not sufficiently detailed to take account of this heterogeneity. Availability of more institution-level data would help to fill this gap and shed more light on this important topic.

A shortcoming of the empirical work conducted in this paper, which should be addressed by future research, is related to the presence of a binary structure in which the management of Spanish HES is decentralized to regional government. It is possible that this decentralized governance of HE might be generating significant results in terms of efficiency – this is one of the key points made in the theories on decentralizing government powers. However, it is difficult to claim that HE is a local public good – because the produced unity of knowledge reflects its effects on all students, regardless of their location: therefore, there is no a priori theoretical evidence that devolution implies better results. Empirical evidence, based on comparisons of Spanish regional HES, should help clarify this issue.

Finally, there is an issue related to the reform processes in the Spanish HES. In recent years, there has been a tendency for policy related to the Spanish HES to focus more on the so called 'strategy for university modernization' – *Estrategia Universidad 2015* (MECyD, 2011b). Under this scheme, universities are called on to cooperate with each other, to enhance their social dimension and contribute to the knowledge generated being channelled towards progress, welfare and competitiveness in the economy and in employment. The aggregation of the Spanish HES might be one strategy that could place Spanish universities in Europe's top 100 ranking, allowing them to compete more effectively, to achieve higher reputation and to command greater international regard. According to the results gathered in this paper, if Spanish HEIs are going to embark on a merger process, they will need to exploit this opportunity to establish appropriate development strategies, introduce advanced technology and equipment in order to attract world-class talented faculty, and promote production technology progress in order to realize a modernization-growth effect. At the same time, universities will need to deepen their internal organization reforms, make continuous readjustments and improve management and resource allocation to achieve catching-up and scale effects, in order for aggregation to be productive, i.e., for one plus one to be bigger than two.

Appendix

[Table A1 about here]

[Table A2 about here]

[Table A3 about here]

[Table A4 about here]

[Table A5 about here]

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Tables

Table 1. Descriptive statistics for inputs and outputs across the 43 universities by year.

Year	Statistics	Undergraduate completions *(number)*	ISI publications *(number)*	Income for private contracts *(€'000s)*	Academic staff FTE *(number)*	Non-acad. Staff FTE *(number)*	Total expenditure *(€'000s)*
1994	Mean	3,107	264	2,026	1,535	743	74,510
	Std deviation	3,215	294	3,064	1,095	580	54,466
	Minimum	459	6	38	285	135	11,710
	Maximum	18,534	1,360	17,979	5,491	2,899	253,392
1995	Mean	3,441	309	2,268	1,784	771	81,356
	Std deviation	3,584	345	2,736	1,345	588	59,107
	Minimum	573	16	106	367	136	11,210
	Maximum	21,367	1,613	14,698	7,352	2,984	272,207
1996	Mean	3,782	340	2,552	1,846	798	90,236
	Std deviation	3,692	370	3,629	1,294	597	62,383
	Minimum	765	15	141	385	183	16,599
	Maximum	22,050	1,741	2,004	6,727	3,017	291,022
1997	Mean	4,090	361	2,757	1,902	841	96,811
	Std deviation	3,747	379	3,148	1,310	630	64,655
	Minimum	846	32	178	411	198	20,476
	Maximum	21,902	1,945	15,887	7,112	3,203	306,509
1998	Mean	4,216	396	3,357	1,806	839	103,386
	Std deviation	3,470	400	3,277	1,182	605	67,599
	Minimum	856	43	214	362	201	24,354
	Maximum	20,559	1,941	11,727	6,019	3,282	321,996
1999	Mean	4,272	411	3,773	1,870	884	110,493
	Std deviation	3,371	392	3,688	1,206	623	69,338
	Minimum	996	55	251	379	205	27,589
	Maximum	19,240	1,956	12,661	6,019	3,303	336,367
2000	Mean	4,219	420	4,287	1,944	927	117,599
	Std deviation	3,160	401	4,663	1,207	653	71,521
	Minimum	832	41	286	379	202	30,824
	Maximum	16,870	2,021	18,807	6,035	3,504	350,738
2001	Mean	4,206	447	4,606	1,902	969	127,299
	Std deviation	3,037	407	4,513	1,197	664	77,538
	Minimum	977	64	232	415	140	30,982
	Maximum	16,095	2,118	18,070	6,021	3,509	385,103
2002	Mean	4,538	462	4,958	1,898	959	136,999
	Std deviation	3,209	401	5,310	1,182	651	83,797
	Minimum	1,083	77	402	419	217	31,141
	Maximum	15,770	2,150	23,945	6,021	3,509	419,468
2003	Mean	4,178	526	6,039	1,952	908	155,436
	Std deviation	3,173	433	6,739	1,177	646	96,902
	Minimum	630	41	379	447	235	31,895
	Maximum	13,826	2,250	35,481	5,961	3,540	454,348
2004	Mean	3,871	530	7,119	1,989	1,016	173,872
	Std deviation	2,611	433	8,514	1,185	678	113,937
	Minimum	267	77	356	477	236	32,650
	Maximum	13,921	2,238	47,016	5,896	3,563	489,371
2005	Mean	3,769	629	8,174	2,030	1,032	174,215
	Std deviation	2,351	532	10,079	1,216	691	110,604
	Minimum	1,014	104	374	462	240	35,174
	Maximum	12,226	2,736	56,287	6,047	3,706	523,311

2006	Mean	3,628	666	9,728	2,070	1,048	176,932
	Std deviation	2,290	544	12,314	1,249	706	113,597
	Minimum	1,048	99	393	446	244	37,892
	Maximum	11,841	2,784	65,559	6,197	3,848	559,769
2007	Mean	3,751	718	9,955	2,124	1,109	196,768
	Std deviation	2,341	617	10,977	1,266	746	123,074
	Minimum	930	112	654	467	280	41,372
	Maximum	12,226	2,900	53,375	6,410	4,098	592,204
2008	Mean	3,551	764	12,019	2,153	1,122	216,604
	Std deviation	2,164	661	16,228	1,296	767	133,047
	Minimum	1,035	101	639	459	252	44,853
	Maximum	11,421	3,240	90,274	6,249	4,136	624,639
94-08	Annual accumulated variation rate	0.89%	7.33%	12.60%	2.28%	2.78%	7.37%

Table 2. Average values and standard deviation of Malmquist index by year.

Year	TFP (Std.Dev.)	PTEC (Std. Dev.)	SEC (Std.Dev.)	TEC (Std.Dev.)	TC (Std.Dev.)
1994-1995	1.027 (0.138)	1.062 (0.154)	1.012 (0.079)	1.075 (0.172)	0.955 (0.094)
1995-1996	1.038 (0.182)	1.019 (0.147)	0.989 (0.071)	1.008 (0.166)	1.030 (0.066)
1996-1997	1.062 (0.172)	1.061 (0.143)	1.012 (0.083)	1.073 (0.185)	0.989 (0.055)
1997-1998	1.064 (0.172)	0.958 (0.169)	1.030 (0.101)	0.987 (0.164)	1.078 (0.088)
1998-1999	0.974 (0.133)	1.032 (0.141)	1.002 (0.092)	1.035 (0.149)	0.941 (0.058)
1999-2000	0.957 (0.107)	0.984 (0.091)	0.986 (0.072)	0.971 (0.108)	0.986 (0.049)
2000-2001	0.987 (0.125)	1.051 (0.137)	1.039 (0.091)	1.093 (0.141)	0.903 (0.067)
2001-2002	1.045 (0.161)	0.923 (0.120)	0.947 (0.090)	0.874 (0.148)	1.196 (0.106)
2002-2003	1.005 (0.135)	0.962 (0.112)	0.949 (0.071)	0.913 (0.116)	1.101 (0.091)
2003-2004	0.940 (0.178)	1.151 (0.224)	1.098 (0.184)	1.264 (0.286)	0.744 (0.151)
2004-2005	0.979 (0.100)	0.953 (0.077)	0.994 (0.042)	0.948 (0.083)	1.032 (0.056)
2005-2006	0.995 (0.103)	1.046 (0.088)	1.024 (0.056)	1.071 (0.100)	0.929 (0.077)
2006-2007	0.971 (0.147)	1.008 (0.114)	0.981 (0.061)	0.989 (0.120)	0.981 (0.079)
2007-2008	0.939 (0.162)	0.990 (0.091)	1.017 (0.067)	1.007 (0.124)	0.933 (0.073)
All years	0.998 (0.042)	1.013 (0.059)	1.005 (0.038)	1.018 (0.095)	0.980 (0.105)

Note: TFP = Total Factor Productivity; PTEC = Pure Technical Efficiency Change; SEC = Scale Efficiency Change; TEC = Technical Efficiency Change; TC= Technological Change.

Table 3. Average values of Malmquist index by university from 1994 to 2008

Name of University	TFP	PTEC	SEC	TEC	TC
U. of Almeria	0.998	1.019	1.022	1.041	0.959
U. of Cadiz	0.970	1.021	1.005	1.026	0.946
U. of Cordoba	1.012	1.013	1.006	1.019	0.993
U. of Granada	0.981	1.015	0.995	1.010	0.971
U. of Huelva	1.007	1.016	1.019	1.035	0.973
U. of Jaen	1.000	1.027	1.021	1.048	0.954
U. of Malaga	0.995	1.010	1.005	1.015	0.980
U. of Seville	0.983	1.042	0.990	1.031	0.953
U. of Zaragoza	0.987	1.004	1.001	1.005	0.982
U. of Oviedo	1.007	1.019	1.001	1.020	0.987
U. of Balearic Island	0.962	0.986	0.999	0.985	0.976
U. of La Laguna	1.011	1.038	1.002	1.040	0.972
U. of Gran Canaria	1.020	1.046	1.001	1.047	0.974
U. of Cantabria	1.013	1.018	1.011	1.030	0.983
Aut. U. of Barcelona	1.000	1.021	1.001	1.022	0.979
U. of Barcelona	0.984	1.000	1.000	1.000	0.984
U. of Gerona	1.018	1.052	1.013	1.066	0.955
U. of Lerida	0.950	0.988	0.989	0.977	0.972
Tech. U. of Catalonia	1.047	1.029	1.000	1.029	1.018
Pompeu Fabra U.	1.052	1.047	1.020	1.068	0.985
Rovira i Virgili U.	1.012	1.022	1.002	1.024	0.989
U. Castilla-Mancha	0.999	1.015	1.004	1.019	0.980
U. of Alicante	0.951	0.978	1.001	0.979	0.972
Jaume I U.	1.021	0.992	1.018	1.010	1.011
Tech. U. of Valencia	1.092	1.029	1.001	1.031	1.060
U. of Valencia	1.000	1.000	0.990	0.990	1.010
U. of Burgos	0.970	0.992	1.021	1.012	0.958
U. of Leon	1.020	1.021	1.014	1.036	0.985
U. of Salamanca	0.968	1.012	0.997	1.009	0.959
U. of Valladolid	0.973	1.013	0.997	1.010	0.963
U. of Extremadura	0.958	1.007	1.008	1.015	0.943
U. of A Corunya	0.944	0.993	1.000	0.993	0.950
U. Sant. Compostela	1.023	1.008	1.002	1.011	1.012
U. of Vigo	0.987	1.012	1.003	1.014	0.973
Alcala U.	0.984	0.994	1.008	1.002	0.982
Aut. U. of Madrid	1.012	1.000	1.000	1.000	1.012
Carlos III U.	1.023	1.000	1.019	1.019	1.004
Comp. U. of Madrid	0.949	1.000	0.987	0.987	0.961
Tech. U. of Madrid	1.119	1.068	1.003	1.071	1.045
U. of Murcia	0.979	1.005	1.002	1.006	0.973
Public U. of Navarra	0.983	0.989	1.020	1.009	0.974
U. of Basque Country	0.961	1.000	0.982	0.982	0.979
U. of La Rioja	1.012	1.000	1.039	1.039	0.974

Note: TFP = Total Factor Productivity; PTEC = Pure Technical Efficiency Change; SEC = Scale Efficiency Change; TEC = Technical Efficiency Change; TC= Technological Change.

Table 4. Correlation coefficients of each index

Year	Corr TFP / PTEC	Corr TFP / SEC	Corr PTEC / SEC	Corr TFP / TEC	Corr TFP / TC
1994-1995	0.567	0.539	-0.082	0.810	0.391
1995-1996	0.784	0.575	0.085	0.929	0.416
1996-1997	0.863	0.556	0.184	0.953	-0.032
1997-1998	0.809	0.046	-0.347	0.881	0.087
1998-1999	0.809	0.198	-0.257	0.902	0.156
1999-2000	0.673	0.488	-0.143	0.898	0.280
2000-2001	0.706	0.223	-0.312	0.837	0.255
2001-2002	0.714	0.457	0.061	0.822	0.115
2002-2003	0.634	0.364	-0.210	0.809	0.367
2003-2004	0.605	0.182	-0.127	0.630	0.291
2004-2005	0.756	0.256	-0.121	0.830	0.514
2005-2006	0.585	0.292	-0.076	0.676	0.463
2006-2007	0.717	0.236	-0.093	0.784	0.566
2007-2008	0.803	0.526	0.215	0.883	0.755

Note: all values are statistically significant at the 10% level.

Table A1. Values of Total Factor Productivity (TFP) of the Spanish Public Universities from 1994 to 2008 by University.

Name of University	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	Average value
U. of Almeria	1.057	0.856	1.384	1.114	0.867	0.921	1.040	0.998	1.037	0.896	0.898	0.948	1.008	1.053	0.998
U. of Cadiz	0.985	1.081	1.291	0.968	0.654	0.903	1.000	1.129	0.908	1.111	0.892	0.926	0.974	0.909	0.970
U. of Cordoba	0.899	1.019	1.084	1.316	1.020	0.989	0.982	1.063	0.940	0.950	0.947	1.105	0.921	1.000	1.012
U. of Granada	0.866	0.944	1.089	1.208	0.882	1.015	1.064	0.893	1.011	0.935	0.919	1.021	0.966	0.981	0.981
U. of Huelva	0.947	1.188	1.568	1.139	0.718	1.068	1.150	0.960	1.057	0.897	0.905	0.945	0.958	0.831	1.007
U. of Jaen	1.063	1.487	1.022	1.081	0.957	0.888	0.902	0.908	1.020	0.906	0.894	1.053	0.874	1.086	1.000
U. of Malaga	1.071	1.007	0.983	1.128	0.926	0.938	1.032	0.977	1.077	1.018	1.208	0.770	1.123	0.776	0.995
U. of Seville	1.110	1.039	1.031	1.108	0.950	0.965	1.023	0.912	0.916	0.919	0.954	0.922	1.018	0.925	0.983
U. Zaragoza	0.963	1.064	1.064	1.075	0.915	0.893	1.012	1.003	1.146	1.024	0.998	0.758	1.015	0.951	0.987
U. Oviedo	1.346	0.862	0.807	1.225	1.037	0.811	1.149	1.297	0.836	0.985	0.916	1.014	1.003	0.996	1.007
U. Balearic Island	0.839	1.051	0.733	0.996	0.924	1.032	0.908	0.881	1.183	1.132	0.995	1.114	0.739	1.073	0.962
U. La Laguna	1.184	1.065	0.954	1.072	0.992	0.913	1.107	0.921	1.003	0.933	1.077	1.015	1.003	0.950	1.011
U. Gran Canaria	0.963	1.216	1.229	1.097	0.931	0.977	1.212	1.424	0.962	0.672	0.891	1.039	0.938	0.949	1.020
U. Cantabria	0.986	1.190	0.833	0.799	1.166	0.859	1.112	1.195	1.138	1.002	1.041	1.013	0.974	0.978	1.013
Aut. of Barcelona	0.996	1.138	0.996	1.069	0.960	0.998	0.982	1.153	0.983	0.735	1.038	1.034	0.992	0.990	1.000
U. Barcelona	0.885	1.092	1.002	0.971	0.972	1.052	0.872	0.893	0.965	1.019	1.166	1.043	0.977	0.912	0.984
U. Gerona	1.167	1.305	1.213	0.886	1.026	1.257	0.842	0.899	0.872	1.127	0.857	1.158	0.948	0.865	1.018
U. Lerida	0.975	0.850	1.274	1.087	0.882	0.781	0.933	1.188	0.930	0.985	1.019	0.844	1.141	0.618	0.950
Tech. of Catalonia	1.057	1.301	0.928	1.036	1.171	0.975	1.071	1.109	1.077	1.048	1.015	1.072	0.937	0.927	1.047
Pompeu Fabra U.	0.974	1.252	1.157	1.163	1.279	0.847	1.261	0.882	0.955	1.451	0.865	0.986	1.009	0.860	1.052
Rovira i Virgili U.	1.826	0.726	1.124	1.017	0.945	0.772	1.003	1.250	1.174	0.877	1.064	1.236	0.764	0.831	1.012
U. Castilla-Mancha	0.997	1.082	1.206	1.096	0.937	1.055	0.880	1.032	0.944	0.924	0.902	1.013	0.927	1.045	0.999
U. of Alicante	0.865	1.125	0.871	0.953	1.032	0.805	0.889	0.899	1.020	0.933	1.050	1.027	0.890	1.006	0.951
Jaume I U.	0.821	1.380	1.198	0.648	1.171	1.164	0.821	1.104	1.076	1.289	0.838	1.192	0.780	1.144	1.021
Tech. of Valencia	1.128	1.312	0.949	1.096	1.032	1.048	1.009	1.074	1.194	0.893	1.202	1.250	1.033	1.156	1.092
U. of Valencia	0.942	0.994	1.091	0.964	1.034	1.068	0.905	1.059	1.043	1.021	0.960	0.979	0.957	1.005	1.000
U. of Burgos	1.338	0.678	1.311	0.912	0.877	1.056	1.039	1.033	0.901	0.960	0.875	0.910	1.014	0.864	0.970
U. of Leon	1.001	1.088	1.012	1.054	1.042	1.061	1.005	0.908	1.135	1.175	0.948	0.934	1.058	0.901	1.020
U. of Salamanca	1.030	0.872	1.262	1.020	1.002	0.961	1.120	1.408	0.987	0.473	0.984	0.967	0.952	0.851	0.968
U. of Valladolid	0.881	1.201	1.095	0.920	1.058	1.016	0.911	0.990	0.937	0.993	0.819	0.946	0.992	0.918	0.973
U. Extremadura	0.931	1.171	0.860	1.295	0.833	0.853	0.957	1.479	0.666	0.950	0.991	0.887	0.904	0.892	0.958
U. A Corunya	0.787	0.931	0.956	1.094	1.011	0.965	1.024	0.992	0.991	0.847	0.889	0.901	1.053	0.824	0.944
Sant. Compostela	1.016	1.091	0.960	1.160	0.856	0.994	1.122	1.048	1.094	1.009	1.078	0.958	1.033	0.943	1.023
U. of Vigo	1.083	0.687	1.412	1.473	1.059	1.004	0.681	1.056	1.055	0.993	0.899	0.868	1.051	0.816	0.987
Alcala U.	1.425	0.664	1.229	1.031	0.909	0.805	1.079	0.919	0.896	0.937	1.081	1.030	0.962	1.015	0.984
Aut. U. Madrid	1.022	0.989	0.923	1.121	1.018	1.060	0.845	1.048	1.187	0.839	1.156	1.097	0.949	0.990	1.012
Carlos III U.	1.047	1.000	0.953	0.894	0.893	1.082	0.877	1.342	1.337	0.697	1.088	0.986	1.135	1.194	1.023
Comp. of Madrid	0.984	1.023	0.946	1.023	0.918	0.882	0.933	0.926	0.867	0.992	0.874	0.959	1.065	0.914	0.949
Tech. of Madrid	1.227	1.063	1.027	1.583	0.866	1.072	1.068	1.229	1.203	1.221	1.080	1.018	0.717	1.612	1.119
U. of Murcia	0.948	0.960	1.051	1.194	1.240	0.783	0.852	0.968	0.952	0.983	0.901	1.070	0.956	0.941	0.979
Public of Navarra	1.094	1.071	1.043	0.793	1.343	0.950	0.869	1.085	1.290	0.552	1.062	1.019	1.703	0.512	0.983
U. Basque Country	0.925	1.114	1.072	1.043	1.035	0.973	0.926	1.088	0.848	0.723	1.008	1.006	0.888	0.894	0.961
U. of La Rioja	1.068	1.124	1.014	1.402	0.899	0.892	1.295	0.810	0.777	1.145	1.053	0.970	0.847	1.068	1.012

Table A2. Values of Technical Efficiency Change (TEC) of the Spanish Public Universities from 1994 to 2008 by University.

Name of University	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	Average value
U. of Almeria	0.961	0.914	1.425	1.142	0.974	0.904	1.221	0.798	0.966	1.430	0.881	1.069	0.981	1.117	1.041
U. of Cadiz	0.952	1.138	1.343	0.969	0.743	0.921	1.125	0.866	0.887	1.691	0.936	1.071	0.985	1.030	1.026
U. of Cordoba	1.015	0.978	0.998	1.281	0.990	1.025	1.015	0.879	0.827	1.348	0.905	1.215	0.867	1.063	1.019
U. of Granada	0.943	0.889	1.067	1.185	0.952	1.038	1.155	0.714	0.871	1.495	0.928	1.153	0.928	1.031	1.010
U. of Huelva	1.017	1.089	1.658	1.019	0.755	1.104	1.149	0.766	0.930	1.477	0.894	1.079	0.973	0.916	1.035
U. of Jaen	1.127	1.422	1.063	1.062	1.077	0.939	1.030	0.728	0.850	1.456	0.937	1.222	0.819	1.216	1.048
U. of Malaga	1.252	0.914	1.010	0.979	0.977	0.943	1.164	0.741	1.143	1.320	1.053	0.931	1.075	0.859	1.015
U. of Seville	1.298	0.937	1.063	1.070	1.085	0.969	1.225	0.662	0.908	1.401	0.955	1.026	1.053	0.992	1.031
U. Zaragoza	1.017	1.005	1.019	1.091	1.020	0.866	1.252	0.874	1.054	1.100	0.961	0.703	1.270	0.988	1.005
U. Oviedo	1.323	0.847	0.782	1.160	1.140	0.830	1.230	1.070	0.684	1.399	0.912	1.119	1.020	1.048	1.020
U. Balearic Island	0.807	1.093	0.670	1.027	0.989	1.015	1.025	0.735	1.088	1.474	0.951	1.145	0.836	1.207	0.985
U. La Laguna	1.058	1.141	0.895	1.092	1.070	0.941	1.205	0.763	0.833	1.423	1.119	1.113	1.043	1.029	1.040
U. Gran Canaria	1.042	1.070	1.309	0.930	1.037	0.976	1.396	1.174	0.932	0.926	0.855	1.143	0.968	1.030	1.047
U. Cantabria	1.162	1.091	0.972	0.792	1.148	0.881	1.270	1.157	1.033	1.010	0.988	0.943	1.091	0.985	1.030
Aut. of Barcelona	0.970	1.141	0.923	1.158	0.984	0.928	1.247	1.000	1.000	0.888	0.942	1.061	1.032	1.091	1.022
U. Barcelona	1.000	1.000	1.000	1.000	0.992	0.934	1.079	1.000	0.927	1.013	1.035	1.029	0.943	1.060	1.000
U. Gerona	1.084	1.413	1.259	0.884	1.152	1.245	0.993	0.689	0.914	1.578	0.802	1.264	1.000	1.000	1.066
U. Lerida	0.888	0.887	1.296	0.958	1.010	0.829	1.031	1.038	0.705	1.560	0.989	0.941	1.186	0.681	0.977
Tech. of Catalonia	1.272	1.252	1.034	0.794	1.339	0.973	1.040	1.000	1.000	1.000	0.935	1.039	0.893	0.972	1.029
Pompeu Fabra U.	1.035	1.222	1.230	1.005	1.371	0.866	1.353	0.765	0.838	1.945	0.810	1.076	1.026	0.898	1.068
Rovira i Virgili U.	1.643	0.790	1.097	1.034	1.002	0.784	1.129	1.213	1.037	0.884	0.980	1.154	0.976	0.866	1.024
U. Castilla-Mancha	0.929	1.025	1.276	0.990	0.945	1.184	0.866	0.805	0.827	1.530	0.906	1.153	0.936	1.129	1.019
U. of Alicante	1.038	1.000	0.942	0.860	1.067	0.820	0.990	0.742	0.904	1.358	1.023	1.082	0.927	1.086	0.979
Jaume I U.	0.845	1.343	1.222	0.525	1.359	1.209	0.900	0.861	0.935	1.399	0.781	1.281	0.795	1.191	1.010
Tech. of Valencia	1.370	1.114	1.000	0.944	0.931	0.968	1.061	0.957	1.086	0.903	1.076	1.098	1.000	1.000	1.031
U. of Valencia	0.968	0.949	1.081	0.933	1.015	1.070	0.936	0.946	0.902	1.222	0.917	1.015	0.931	1.020	0.990
U. of Burgos	1.274	0.678	1.349	0.833	0.904	1.173	1.069	0.791	0.838	1.540	0.882	1.078	1.089	1.022	1.012
U. of Leon	1.161	0.981	1.058	0.929	1.061	1.098	0.982	0.737	1.044	1.660	0.875	1.079	1.060	1.000	1.036
U. of Salamanca	1.081	0.815	1.232	0.961	1.059	1.005	1.225	1.023	1.000	0.779	1.023	1.071	1.001	0.959	1.009
U. of Valladolid	0.883	1.174	1.101	0.835	1.204	1.066	1.007	0.786	0.969	1.312	0.816	1.097	1.000	1.049	1.010
U. Extremadura	0.989	1.102	0.906	1.255	0.967	0.877	1.162	1.015	0.772	1.296	1.000	1.000	1.000	1.000	1.015
U. A Corunya	1.000	1.000	1.000	0.870	1.150	1.000	1.000	0.832	0.876	1.372	0.878	1.049	1.086	0.904	0.993
Sant. Compostela	1.159	1.000	0.912	1.096	0.888	0.905	1.245	1.000	1.000	1.000	0.993	1.004	1.004	1.000	1.011
U. of Vigo	1.161	0.714	1.401	1.187	1.000	1.000	0.921	0.876	0.840	1.476	1.000	1.000	1.000	0.885	1.014
Alcala U.	1.259	0.730	1.127	1.011	0.937	0.836	1.184	0.808	0.774	1.328	1.087	1.161	0.928	1.085	1.002
Aut. U. Madrid	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Carlos III U.	1.201	0.933	0.890	0.783	1.005	1.084	0.938	1.116	1.062	0.929	1.019	0.963	1.303	1.154	1.019
Comp. of Madrid	1.000	1.000	1.000	1.000	1.000	0.917	1.052	0.704	0.818	1.615	0.823	1.130	1.030	0.966	0.987
Tech. of Madrid	1.428	1.014	1.027	1.354	0.910	1.075	1.331	1.000	1.000	1.000	1.000	1.000	0.759	1.317	1.071
U. of Murcia	1.011	0.906	1.020	1.157	1.222	0.897	0.895	0.799	0.824	1.506	0.902	1.123	0.993	1.032	1.006
Public of Navarra	1.240	0.958	1.072	0.697	1.490	0.942	0.897	0.976	1.152	0.866	1.021	1.150	1.325	0.668	1.009
U. Basque Country	0.880	1.136	1.000	0.919	1.088	1.000	1.000	1.000	0.808	1.029	1.068	1.115	0.856	0.917	0.982
U. of La Rioja	0.999	1.097	1.058	1.285	0.902	0.938	1.357	0.677	0.701	1.782	1.059	1.115	0.848	1.180	1.039

Table A3. Values of Pure Technical Efficiency Change (PTEC) of the Spanish Public Universities from 1994 to 2008 by University.

Name of University	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	Average value
U. of Almeria	0.946	0.913	1.375	0.962	1.045	1.035	1.039	0.850	1.063	1.165	0.865	1.009	1.035	1.063	1.019
U. of Cadiz	0.925	1.188	1.335	0.903	0.740	0.927	1.125	0.904	0.935	1.552	0.929	1.067	0.996	1.014	1.021
U. of Cordoba	1.008	0.981	0.992	1.211	1.001	0.989	1.034	0.949	0.870	1.177	0.935	1.166	0.880	1.051	1.013
U. of Granada	0.942	0.882	1.081	1.168	0.964	1.097	1.110	0.749	1.002	1.324	0.988	1.018	1.000	1.000	1.015
U. of Huelva	1.075	1.040	1.441	0.943	0.770	1.094	1.139	0.859	1.080	1.137	0.888	1.022	1.038	0.858	1.016
U. of Jaen	1.098	1.332	1.000	1.000	1.000	0.992	1.008	0.867	0.900	1.199	0.925	1.156	0.974	1.020	1.027
U. of Malaga	1.234	0.893	1.013	0.945	0.979	1.000	1.104	0.758	1.156	1.289	1.035	0.960	1.041	0.859	1.010
U. of Seville	1.285	0.943	1.059	1.300	0.893	1.094	1.090	0.802	0.974	1.276	1.003	0.996	1.004	1.000	1.042
U. Zaragoza	1.027	0.993	1.031	1.066	1.017	0.924	1.204	0.854	1.052	1.133	1.005	0.790	1.095	0.945	1.004
U. Oviedo	1.301	0.866	0.777	1.235	1.062	0.828	1.261	1.058	0.682	1.401	0.903	1.148	1.002	1.033	1.019
U. Balearic Island	1.000	1.000	0.977	0.720	1.035	1.011	0.872	0.802	1.198	1.377	0.904	1.057	0.839	1.207	0.986
U. La Laguna	1.037	1.184	0.887	1.054	1.070	0.948	1.198	0.782	0.848	1.389	1.098	1.142	1.032	1.012	1.038
U. Gran Canaria	1.082	1.079	1.289	0.894	1.042	1.029	1.380	1.212	0.927	0.859	0.865	1.170	0.937	1.026	1.046
U. Cantabria	1.131	1.142	0.981	0.745	1.288	0.750	1.382	0.988	1.037	1.000	1.000	1.000	1.000	1.000	1.018
Aut. of Barcelona	0.964	1.149	0.929	1.138	0.987	0.978	1.174	1.000	1.000	0.925	0.978	1.043	1.004	1.054	1.021
U. Barcelona	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
U. Gerona	1.049	1.497	1.241	0.820	1.187	1.074	1.000	0.847	0.941	1.254	0.840	1.190	1.000	1.000	1.052
U. Lerida	0.919	1.030	1.056	1.000	1.000	1.000	0.834	1.199	0.926	0.995	0.971	0.889	1.219	0.870	0.988
Tech. of Catalonia	1.487	1.079	1.092	1.009	1.000	1.000	1.000	1.000	1.000	1.000	0.936	1.042	0.914	0.944	1.029
Pompeu Fabra U.	0.898	1.234	1.158	0.951	1.397	0.838	1.413	0.850	0.801	1.863	0.796	1.011	1.054	0.879	1.047
Rovira i Virgili U.	1.369	0.973	1.027	1.000	1.000	0.918	0.962	1.131	1.000	1.000	0.994	1.006	1.000	0.988	1.022
U. Castilla-Mancha	0.965	1.016	1.232	0.955	0.942	1.188	0.907	0.773	0.832	1.550	0.909	1.171	0.921	1.084	1.015
U. of Alicante	1.019	1.000	0.995	0.815	1.077	0.853	0.943	0.764	0.914	1.309	1.019	1.150	0.894	1.060	0.978
Jaume I U.	0.812	1.372	1.152	0.530	1.240	1.166	0.873	0.951	0.985	1.315	0.737	1.211	0.829	1.141	0.992
Tech. of Valencia	1.423	1.053	1.000	1.000	1.000	0.941	0.960	0.968	1.079	0.910	1.064	1.097	1.000	1.000	1.029
U. of Valencia	0.978	0.937	1.090	0.923	1.045	1.038	1.000	0.919	0.959	1.135	1.000	0.974	1.005	1.019	1.000
U. of Burgos	1.000	0.933	1.071	0.820	0.930	1.112	1.045	0.919	0.999	1.138	0.865	1.040	1.176	0.909	0.992
U. of Leon	1.162	0.959	0.980	0.882	1.087	1.075	0.979	0.800	1.147	1.329	0.905	1.049	1.054	1.000	1.021
U. of Salamanca	1.086	0.810	1.240	0.924	1.062	1.027	1.207	1.012	1.000	0.829	1.016	1.070	1.037	0.942	1.012
U. of Valladolid	0.879	1.167	1.106	0.888	1.152	1.048	1.000	0.797	0.991	1.265	0.859	1.053	1.057	1.029	1.013
U. Extremadura	0.973	1.117	0.871	1.166	0.968	0.936	1.097	1.006	0.851	1.175	1.000	1.000	1.000	1.000	1.007
U. A Corunya	1.000	1.000	1.000	0.876	1.141	1.000	1.000	0.897	0.913	1.222	0.893	1.072	1.044	0.906	0.993
Sant. Compostela	1.123	1.000	0.945	1.058	0.925	0.905	1.193	1.000	1.000	1.000	0.996	1.004	1.000	1.000	1.008
U. of Vigo	1.117	0.763	1.396	1.108	1.000	1.000	0.927	0.921	0.856	1.369	1.000	1.000	1.000	0.893	1.012
Alcala U.	1.130	0.769	1.156	0.937	0.975	0.835	1.142	0.851	0.752	1.289	1.091	1.181	0.911	1.082	0.994
Aut. U. Madrid	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Carlos III U.	1.000	1.000	1.000	0.775	0.817	1.087	0.889	1.214	1.067	0.868	1.028	0.933	1.468	1.033	1.000
Comp. of Madrid	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Tech. of Madrid	1.400	0.991	1.033	1.413	1.239	0.905	1.105	1.000	1.000	1.000	1.000	1.000	0.846	1.183	1.068
U. of Murcia	1.026	0.908	1.004	1.109	1.221	0.908	0.886	0.824	0.833	1.463	0.890	1.190	0.981	1.003	1.005
Public of Navarra	1.272	0.980	0.981	0.613	1.462	0.959	1.084	0.916	1.218	0.722	0.994	1.060	1.315	0.671	0.989
U. Basque Country	0.940	1.064	1.000	1.000	1.000	1.000	1.000	1.000	0.854	1.171	1.000	1.000	1.000	1.000	1.000
U. of La Rioja	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table A4. Values of Scale Efficiency Change (SEC) of the Spanish Public Universities from 1994 to 2008 by University.

Name of University	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	Average value
U. of Almeria	1.016	1.001	1.036	1.187	0.932	0.874	1.176	0.938	0.908	1.228	1.019	1.059	0.947	1.051	1.022
U. of Cadiz	1.029	0.958	1.006	1.073	1.005	0.994	1.001	0.958	0.948	1.090	1.007	1.004	0.989	1.016	1.005
U. of Cordoba	1.007	0.997	1.007	1.058	0.988	1.036	0.982	0.927	0.950	1.146	0.968	1.042	0.984	1.012	1.006
U. of Granada	1.001	1.008	0.987	1.015	0.988	0.947	1.041	0.953	0.869	1.129	0.939	1.133	0.928	1.031	0.995
U. of Huelva	0.945	1.047	1.150	1.080	0.981	1.010	1.009	0.892	0.860	1.299	1.007	1.056	0.937	1.067	1.019
U. of Jaen	1.027	1.067	1.063	1.062	1.077	0.947	1.021	0.840	0.945	1.215	1.013	1.058	0.841	1.191	1.021
U. of Malaga	1.014	1.024	0.997	1.036	0.999	0.943	1.054	0.978	0.989	1.024	1.017	0.969	1.032	1.000	1.005
U. of Seville	1.011	0.993	1.004	0.823	1.215	0.885	1.124	0.825	0.932	1.098	0.952	1.029	1.049	0.992	0.990
U. Zaragoza	0.990	1.012	0.989	1.024	1.004	0.937	1.040	1.023	1.002	0.971	0.956	0.889	1.160	1.045	1.001
U. Oviedo	1.017	0.978	1.006	0.940	1.073	1.003	0.975	1.011	1.002	0.999	1.010	0.975	1.019	1.015	1.001
U. Balearic Island	0.807	1.093	0.685	1.426	0.955	1.004	1.175	0.917	0.908	1.071	1.052	1.084	0.997	1.000	0.999
U. La Laguna	1.020	0.963	1.009	1.036	1.000	0.993	1.006	0.976	0.982	1.025	1.019	0.974	1.010	1.017	1.002
U. Gran Canaria	0.963	0.992	1.015	1.040	0.995	0.948	1.011	0.968	1.005	1.078	0.989	0.977	1.034	1.004	1.001
U. Cantabria	1.027	0.955	0.991	1.063	0.891	1.174	0.919	1.171	0.997	1.010	0.988	0.943	1.091	0.985	1.011
Aut. of Barcelona	1.006	0.993	0.994	1.017	0.997	0.948	1.062	1.000	1.000	0.960	0.963	1.017	1.028	1.035	1.001
U. Barcelona	1.000	1.000	1.000	1.000	0.992	0.934	1.079	1.000	0.927	1.013	1.035	1.029	0.943	1.060	1.000
U. Gerona	1.033	0.944	1.014	1.078	0.970	1.159	0.993	0.813	0.971	1.258	0.954	1.062	1.000	1.000	1.013
U. Lerida	0.966	0.861	1.227	0.958	1.010	0.829	1.235	0.866	0.762	1.568	1.019	1.059	0.973	0.783	0.989
Tech. of Catalonia	0.855	1.160	0.947	0.786	1.339	0.973	1.040	1.000	1.000	1.000	0.998	0.997	0.976	1.029	1.000
Pompeu Fabra U.	1.152	0.991	1.062	1.057	0.981	1.033	0.958	0.901	1.046	1.044	1.017	1.064	0.973	1.022	1.020
Rovira i Virgili U.	1.201	0.811	1.068	1.034	1.002	0.854	1.173	1.072	1.037	0.884	0.985	1.148	0.976	0.877	1.002
U. Castilla-Mancha	0.962	1.008	1.035	1.036	1.004	0.997	0.956	1.041	0.994	0.987	0.996	0.985	1.016	1.042	1.004
U. of Alicante	1.018	1.000	0.947	1.056	0.990	0.961	1.050	0.971	0.989	1.038	1.003	0.940	1.036	1.025	1.001
Jaume I U.	1.041	0.979	1.060	0.991	1.095	1.037	1.032	0.905	0.950	1.064	1.059	1.058	0.959	1.044	1.018
Tech. of Valencia	0.962	1.058	1.000	0.944	0.931	1.029	1.106	0.989	1.007	0.993	1.011	1.001	1.000	1.000	1.001
U. of Valencia	0.990	1.013	0.991	1.011	0.971	1.031	0.936	1.030	0.940	1.077	0.917	1.042	0.927	1.001	0.990
U. of Burgos	1.274	0.726	1.259	1.015	0.972	1.055	1.023	0.861	0.839	1.353	1.020	1.036	0.926	1.125	1.021
U. of Leon	0.999	1.023	1.079	1.054	0.976	1.022	1.002	0.922	0.911	1.249	0.967	1.029	1.006	1.000	1.014
U. of Salamanca	0.996	1.006	0.993	1.040	0.997	0.979	1.014	1.011	1.000	0.940	1.007	1.002	0.965	1.018	0.997
U. of Valladolid	1.005	1.006	0.995	0.940	1.044	1.017	1.007	0.986	0.978	1.037	0.950	1.042	0.946	1.019	0.997
U. Extremadura	1.016	0.986	1.039	1.077	0.999	0.936	1.059	1.010	0.907	1.103	1.000	1.000	1.000	1.000	1.008
U. A Corunya	1.000	1.000	1.000	0.993	1.007	1.000	1.000	0.928	0.960	1.122	0.983	0.978	1.040	0.999	1.000
Sant. Compostela	1.032	1.000	0.965	1.036	0.959	0.999	1.043	1.000	1.000	1.000	0.997	0.999	1.004	1.000	1.002
U. of Vigo	1.039	0.936	1.004	1.071	1.000	1.000	0.994	0.951	0.981	1.078	1.000	1.000	1.000	0.991	1.003
Alcala U.	1.114	0.949	0.975	1.079	0.961	1.001	1.036	0.949	1.028	1.030	0.996	0.983	1.018	1.003	1.008
Aut. U. Madrid	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Carlos III U.	1.201	0.933	0.890	1.010	1.230	0.997	1.055	0.919	0.995	1.071	0.991	1.032	0.888	1.118	1.019
Comp. of Madrid	1.000	1.000	1.000	1.000	1.000	0.917	1.052	0.704	0.818	1.615	0.823	1.130	1.030	0.966	0.987
Tech. of Madrid	1.020	1.023	0.994	0.959	0.734	1.188	1.205	1.000	1.000	1.000	1.000	1.000	0.898	1.114	1.003
U. of Murcia	0.985	0.998	1.016	1.043	1.001	0.988	1.009	0.969	0.989	1.029	1.013	0.943	1.012	1.029	1.002
Public of Navarra	0.975	0.978	1.093	1.136	1.019	0.982	0.828	1.065	0.946	1.199	1.027	1.084	1.008	0.996	1.020
U. Basque Country	0.936	1.068	1.000	0.919	1.088	1.000	1.000	1.000	0.947	0.879	1.068	1.115	0.856	0.917	0.982
U. of La Rioja	0.999	1.097	1.058	1.285	0.902	0.938	1.357	0.677	0.701	1.782	1.059	1.115	0.848	1.180	1.039

Table A5. Values of Technological Change (TC) of the Spanish Public Universities from 1994 to 2008 by University.

Name of University	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	Average value
U. of Almeria	1.100	0.936	0.971	0.976	0.890	1.019	0.852	1.251	1.074	0.627	1.018	0.887	1.028	0.943	0.959
U. of Cadiz	1.035	0.950	0.961	0.999	0.880	0.981	0.889	1.304	1.024	0.657	0.953	0.865	0.989	0.883	0.946
U. of Cordoba	0.885	1.042	1.086	1.028	1.031	0.965	0.967	1.208	1.137	0.705	1.046	0.909	1.063	0.941	0.993
U. of Granada	0.918	1.062	1.020	1.019	0.927	0.978	0.921	1.251	1.161	0.626	0.990	0.885	1.040	0.951	0.971
U. of Huelva	0.931	1.091	0.946	1.119	0.951	0.968	1.001	1.253	1.137	0.607	1.012	0.875	0.985	0.907	0.973
U. of Jaen	0.943	1.046	0.961	1.018	0.889	0.946	0.876	1.248	1.200	0.622	0.954	0.862	1.067	0.893	0.954
U. of Malaga	0.856	1.101	0.974	1.152	0.948	0.995	0.887	1.318	0.942	0.771	1.147	0.827	1.045	0.903	0.980
U. of Seville	0.855	1.109	0.970	1.036	0.876	0.996	0.836	1.378	1.009	0.656	0.999	0.899	0.967	0.932	0.953
U. Zaragoza	0.947	1.059	1.044	0.985	0.897	1.031	0.808	1.148	1.087	0.931	1.039	1.079	0.800	0.963	0.982
U. Oviedo	1.018	1.018	1.032	1.056	0.910	0.977	0.934	1.213	1.223	0.704	1.004	0.906	0.983	0.950	0.987
U. Balearic Island	1.040	0.962	1.095	0.970	0.934	1.016	0.886	1.199	1.087	0.768	1.047	0.973	0.884	0.889	0.976
U. La Laguna	1.119	0.934	1.065	0.982	0.927	0.970	0.918	1.208	1.204	0.656	0.963	0.912	0.962	0.923	0.972
U. Gran Canaria	0.925	1.136	0.939	1.180	0.898	1.001	0.868	1.213	1.033	0.725	1.041	0.909	0.969	0.922	0.974
U. Cantabria	0.848	1.091	0.857	1.010	1.016	0.975	0.875	1.033	1.101	0.992	1.054	1.074	0.893	0.993	0.983
Aut. of Barcelona	1.027	0.997	1.078	0.923	0.976	1.076	0.788	1.153	0.983	0.827	1.102	0.975	0.961	0.907	0.979
U. Barcelona	0.885	1.092	1.002	0.971	0.980	1.126	0.808	0.893	1.041	1.006	1.127	1.014	1.035	0.860	0.984
U. Gerona	1.077	0.923	0.963	1.002	0.891	1.010	0.848	1.305	0.954	0.714	1.068	0.916	0.948	0.865	0.955
U. Lerida	1.099	0.959	0.983	1.134	0.873	0.943	0.905	1.144	1.319	0.631	1.030	0.897	0.962	0.907	0.972
Tech. of Catalonia	0.831	1.039	0.897	1.305	0.875	1.002	1.030	1.109	1.077	1.048	1.086	1.032	1.049	0.953	1.018
Pompeu Fabra U.	0.941	1.024	0.940	1.157	0.933	0.978	0.932	1.153	1.140	0.746	1.068	0.916	0.983	0.957	0.985
Rovira i Virgili U.	1.111	0.919	1.025	0.983	0.943	0.984	0.889	1.030	1.132	0.992	1.086	1.071	0.783	0.959	0.989
U. Castilla-Mancha	1.073	1.056	0.945	1.108	0.991	0.891	1.015	1.282	1.142	0.604	0.995	0.878	0.991	0.926	0.980
U. of Alicante	0.834	1.125	0.925	1.108	0.967	0.981	0.898	1.212	1.129	0.687	1.027	0.950	0.960	0.926	0.972
Jaume I U.	0.971	1.028	0.981	1.234	0.862	0.963	0.912	1.282	1.151	0.921	1.073	0.930	0.982	0.961	1.011
Tech. of Valencia	0.824	1.178	0.949	1.161	1.109	1.083	0.951	1.123	1.099	0.989	1.117	1.139	1.033	1.156	1.060
U. of Valencia	0.973	1.047	1.010	1.032	1.019	0.998	0.966	1.120	1.156	0.835	1.047	0.965	1.028	0.986	1.010
U. of Burgos	1.051	1.000	0.972	1.095	0.971	0.900	0.972	1.305	1.074	0.623	0.992	0.844	0.930	0.845	0.958
U. of Leon	0.862	1.109	0.957	1.134	0.982	0.966	1.024	1.231	1.087	0.708	1.084	0.866	0.998	0.901	0.985
U. of Salamanca	0.952	1.071	1.025	1.061	0.947	0.956	0.914	1.375	0.987	0.607	0.962	0.903	0.951	0.888	0.959
U. of Valladolid	0.998	1.022	0.995	1.102	0.879	0.954	0.905	1.259	0.967	0.757	1.004	0.862	0.992	0.876	0.963
U. Extremadura	0.942	1.063	0.949	1.031	0.862	0.974	0.824	1.457	0.863	0.734	0.991	0.887	0.904	0.892	0.943
U. A Corunya	0.787	0.931	0.956	1.258	0.879	0.965	1.024	1.192	1.131	0.618	1.013	0.859	0.970	0.912	0.950
Sant. Compostela	0.876	1.091	1.052	1.058	0.964	1.099	0.901	1.048	1.094	1.009	1.086	0.955	1.030	0.943	1.012
U. of Vigo	0.933	0.963	1.008	1.241	1.059	1.004	0.740	1.205	1.256	0.673	0.899	0.868	1.051	0.922	0.973
Alcala U.	1.132	0.910	1.090	1.020	0.970	0.963	0.911	1.138	1.158	0.705	0.995	0.887	1.037	0.936	0.982
Aut. U. Madrid	1.022	0.989	0.923	1.121	1.018	1.060	0.845	1.048	1.187	0.839	1.156	1.097	0.949	0.990	1.012
Carlos III U.	0.872	1.072	1.071	1.143	0.888	0.998	0.934	1.203	1.260	0.750	1.068	1.024	0.871	1.034	1.004
Comp. of Madrid	0.984	1.023	0.946	1.023	0.918	0.962	0.887	1.315	1.060	0.614	1.062	0.848	1.034	0.946	0.961
Tech. of Madrid	0.860	1.049	1.001	1.169	0.952	0.998	0.803	1.229	1.203	1.221	1.080	1.018	0.945	1.224	1.045
U. of Murcia	0.937	1.060	1.030	1.032	1.014	0.872	0.952	1.211	1.155	0.653	1.000	0.953	0.963	0.912	0.973
Public of Navarra	0.882	1.118	0.973	1.139	0.901	1.009	0.969	1.112	1.120	0.638	1.040	0.886	1.286	0.765	0.974
U. Basque Country	1.051	0.981	1.072	1.135	0.951	0.973	0.926	1.088	1.050	0.703	0.944	0.902	1.038	0.975	0.979
U. of La Rioja	1.069	1.025	0.958	1.091	0.996	0.951	0.954	1.196	1.108	0.643	0.994	0.870	0.999	0.906	0.974