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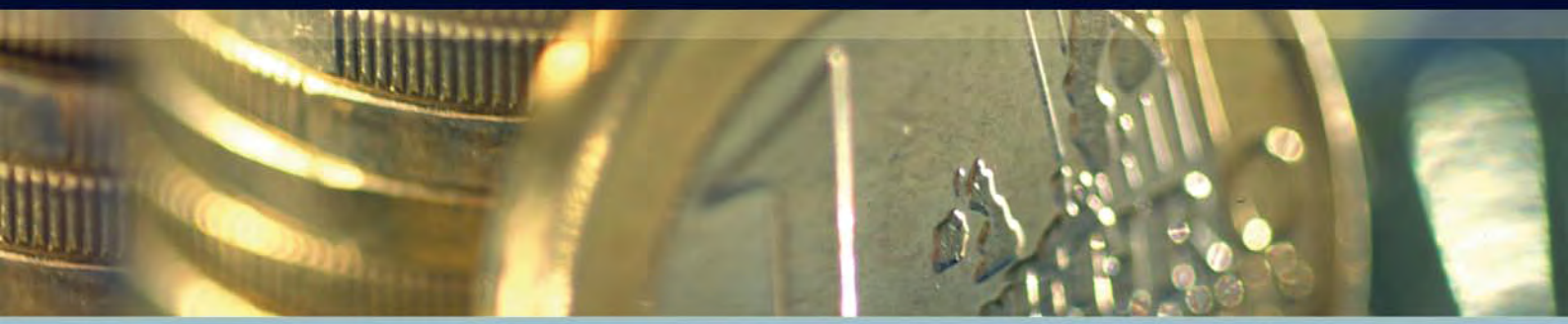

Study on the efficiency and effectiveness of public spending on tertiary education

Miguel St. Aubyn, Álvaro Pina, Filomena Garcia and Joana Pais

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Study on the efficiency and effectiveness of public spending on tertiary education

Third report (second draft)

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Abstract: Public tertiary education systems in the EU Member States are studied by comparing used resources with education and research outputs and outcomes. Efficiency in public tertiary education systems across EU countries plus Japan and the US is assessed with semi-parametric methods and stochastic frontier analysis. A core group of efficient countries is identified. A good quality secondary system, output-based funding rules, institutions' independent evaluation, and staff policy autonomy are positively related to efficiency. Moreover, evidence is provided that public spending on tertiary education is more effective in what concerns labour productivity growth and employability when it is coupled with efficiency.

Key words: efficiency; effectiveness; public spending; tertiary education; universities

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Introduction

This is the final report of a study on the efficiency and effectiveness of public spending on tertiary education in the EU commissioned by the Directorate General Economic and Financial Affairs of the European Commission to an ISEG/Technical University of Lisbon team, under contract number ECFIN/329/2007/486218.

In this report we outline the conceptual framework, present data, and discuss the appropriate input, output, and environment indicators, and take into account the specific features of each country in order to compare properly the tertiary education systems in the EU Member States. Special care is given to the wide-ranging nature of tertiary education, where research and teaching activities cohabit from the individual to the institutional level.

Efficiency of public spending on tertiary education is evaluated using two different methods: a semi-parametric method and the stochastic frontier analysis (SFA). The first method includes data envelopment analysis (DEA) as a first stage and the regression of the obtained efficiency scores on explanatory factors as a second step. The latter is essentially a regression of total tertiary education cost on the considered outputs and factor costs, including the explicit modelling of country-specific efficiency scores. Results from the semi-parametric and SFA methods are essentially consistent. A core of more efficient European countries is identified (the UK and the Netherlands), while important inefficiencies are recognised in other countries. Countries with secondary education systems of good quality and where tertiary education is organised along certain lines (in terms of staff policy autonomy and flexibility, of independent and public evaluation of institutions, and of output oriented funding rules) tend to obtain better results in education and research from the resources used.

Effectiveness of tertiary education is the relation between this activity and final goals rather than closely related outputs. As a matter of fact, tertiary education is one of the driving forces of growth. In this report we show that there is a link between labour and total factor productivity and spending in education. However, this link is only effective when spending is efficient. In other words, what really matters is that money and resources are spent in such a way that one gets outputs that in a broader layer are related to productivity and growth. Moreover, we present evidence of a link between tertiary education efficiency and

employability. Unemployment rates among tertiary education graduates are lower than those among individuals that attained secondary level only, and this difference increases when public tertiary education is more efficient.

This report is organised as follows. The first section covers the important definitions of efficiency, effectiveness, and related concepts and sets some key measurement issues. We include a description of collected data and present some indicators constructed from them. The analysis provided is introductory and intends essentially to describe data and their usefulness for the subject at hand, and to give the reader a first impression of the main issues at stake. The second section describes the methods to be followed in order to assess efficiency on tertiary education provision across countries and its determinants and presents results from the application of semi-parametric and stochastic frontier methods. The third section is focused on the effectiveness of public spending on tertiary education. An annex contains three case studies, two concerning more efficient countries (the Netherlands, the UK) and one about a less efficient system (Portugal). Finally, the report ends with the conclusions that can be drawn from our study.

1. Concepts, data and preliminary analysis

1.1 Concepts

Definition of efficiency

Efficiency is essentially a comparison between inputs used in a certain activity and produced outputs. When, with a given amount of inputs or resources, a decision making unit (DMU) – be it a company, a government body, or a country – attains that level of output or outputs that is the maximum attainable under the existing technology, that DMU is said to be efficient, i.e., it operates on the *production possibility frontier*. When it produces less than what can possibly be attained, the DMU is considered to be inefficient.

FIGURE 1: THE PRODUCTION POSSIBILITY FRONTIER

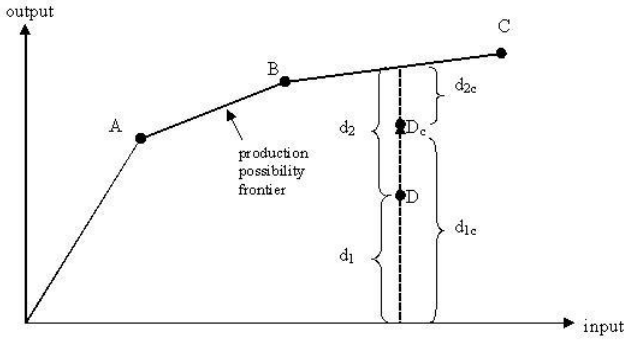


Figure 1 illustrates these concepts in a simplified one input – one output framework. DMUs A, B, and C are located on the production possibility frontier, and are therefore efficient. On the other hand, DMU D is inefficient. With the level of input it uses it produces d_1 units of output. Production should increase by d_2 units if the possibility frontier were to be attained. A possible measure of DMU D's inefficiency is the so-called output efficiency coefficient, $(d_1+d_2)/d_1$, related to the vertical distance to the frontier. In a similar manner, it is possible to measure an input efficiency coefficient, associated to the horizontal distance to the frontier.

A dual approach to efficiency measurement is adequate when more that one output is to be considered and the researcher uses a parametric method like stochastic frontier analysis. This dual approach implies the estimation of a cost frontier, instead of a production frontier. The cost frontier will be a function of outputs and of input costs. Inefficiency will in this case be

evaluated as a measure of the excess cost each unit is incurring relative to minimum (efficient) cost.

Applying these concepts to tertiary education entails defining the DMUs, characterizing inputs and outputs, and also developing a method or methods to estimate the production or cost frontiers, all points to be covered in what follows.

The decision-making units

One of the main objectives of the study is to compare the EU Member States and a country-level analysis is envisaged. Accordingly, the DMU set includes the different public tertiary education systems, which roughly corresponds to all public instructional educational institutions of tertiary education across the EU (to be made precise below). Luxembourg was excluded as its only university was only established in 2003. Japan and the US are also taken in the analysis in order to gain more insight and to add statistical significance to the results. However, in practice, effective consideration of all these countries will depend on data availability. Countries to be considered in the study are listed in Table 1.

TABLE 1: COUNTRIES TO BE CONSIDERED IN THE STUDY

Country Name	Country Code	Country Name	Country Code
Austria	AT	**Italy**	IT
Belgium	BE	**Japan**	JP
Bulgaria	BG	**Lithuania**	LT
Cyprus	CY	**Latvia**	LV
Czech Republic	CZ	**Malta**	MT
Germany	DE	**Netherlands**	NL
Denmark	DK	**Poland**	PL
Estonia	EE	**Portugal**	PT
Greece	EL	**Romania**	RO
Spain	ES	**Sweden**	SE
Finland	FI	**Slovenia**	SI
France	FR	**Slovak Republic**	SK
Hungary	HU	**United Kingdom**	UK
Ireland	IE	**United States**	US

Finally, note that Table 1 contains both small and large countries. In order to have a meaningful comparison, variables will usually be taken in *per capita* terms, i.e., divided by population.

Public system vs. private system

This study is integrated in the study of efficiency and effectiveness of public spending. As such, the institutions under analysis in each country are either public or government-dependent private. These concepts, as defined in European Commission (2007), are:

- **public institutions**: institutions that are directly or indirectly administered by a public education authority;
- **private government-dependent institutions**: institutions that are directly or indirectly administered by a non-governmental organisation (church, trade union, a private business concern, or other body) and which, according to the definition in the UNESCO-UIS/OECD/Eurostat (UOE) questionnaire, receive over 50% of their core funding from the public authorities;
- **private independent institutions**: institutions that are directly or indirectly administered by a non-governmental organisation (church, trade union, a private business concern, or other body) and which, according to the definition in the UOE questionnaire, receive less than 50% of their core funding from the public authorities.

Table 2 summarises the structure of the tertiary education systems in each country under study. In ideal terms, one would like to include all public institutions, and weight each private government-dependent institution according to the percentage of funds it receives from public sources. Such detailed data is not available. As a matter of fact, it was not even possible to obtain a list of private government-dependent institutions per country. However, we could obtain lists of public and or private institutions per country. We have then considered in our sample:

- all institutions, when, in one given country, institutions are all either public or public and private government-dependent;
- public institutions only, when there are some private independent institutions. In these cases, private government-dependent institutions, if they exist, could not be considered, as it was not possible to disentangle them from the private independent institutions. This happened for France, Germany, and Spain;
- public and government-dependent institutions, when both are important, whereas independent private institutions are negligible. This is the case of Estonia, Latvia, Lithuania, and Slovenia.

In what follows, we will refer to the institutions we have considered in each country, be it public only or both public and government-dependent, by PGD.

TABLE 2: STRUCTURE OF TERTIARY EDUCATION SYSTEMS

	Public	Private Government-Dependent	Private Independent	Institutions to Consider	Observations
Austria	X	X		All	
Belgium	X	X		All	
Bulgaria	X		X	Public institutions	
Cyprus	X		X	Public institutions	
Czech Republic	X		X	Public institutions	Some negligible private government-dependent institutions exist.
Denmark	X			All	
Estonia	X	X	X	Public and gov. dependent inst.	Some negligible private institutions exist.
Finland	X	X		All	
France	X	X	X	Public institutions	
Germany	X	X	X	Public institutions	
Greece	X			All	
Hungary	X	X		All	
Ireland	X		X	Public institutions	
Italy	X		X	Public institutions	
Japan	X		X	Public institutions	
Latvia	X	X	X	Public and gov. dependent inst.	
Lithuania	X	X	X	Public and gov. dependent inst.	Private universities are few and negligible.
Malta	X			All	
Netherlands	X	X		All	
Poland	X	X	X	Public institutions	Some negligible private government-dependent institutions exist.
Portugal	X		X	Public institutions	
Romania	X		X	Public institutions	
Slovakia	X		X	All	Some negligible private institutions exist.
Slovenia	X	X	X	Public and gov. dependent inst.	Some negligible private government-dependent institutions exist.
Spain	X	X	X	Public institutions	Some negligible private government-dependent institutions exist.
Sweden	X	X		All	
United Kingdom	X	X		All	
United States	X		X	Public institutions	

Source: OECD Online Education Database, complemented by inspection of government websites.

Outputs and their measurement

Tertiary educational systems are supposed to produce and disseminate knowledge, and this activity is pursued along two main dimensions: teaching and research. It is important

therefore to properly define outputs that are at the same time measurable, not too numerous relative to the number of DMUs to be studied, and clearly related to teaching and research.

As in other studies concerning the efficiency of universities, measures of the number of graduates will be considered as outputs of teaching activities.[2] Quality of teaching is to be measured by resorting to survey data. The THES (Times Higher Education Supplement) - QS (Quacquarelli Symonds) World University Rankings provide data on two important surveys.[3] One concerns graduates' employability as perceived by recruiters and the other relates to quality perceptions among peers. These surveys provide scores on individual universities. In a process to be described later, we computed country scores from those original university scores and obtained a "recruiter view country indicator" and a "peer view country indicator." These indicators will be used to scale the number of graduates in each country.

Research output is to be evaluated by means of measures derived from the number of publications and their impact. We aggregate to country level the number of published papers in academic journals by considering the location of the authors' affiliation. Furthermore, quality of such publications is taken into account by means of the number of citations received. In fact, in a manner to be made precise below, we have computed a citation index, which we then use to weight the number of publications. The Web of Science database elaborated by The Thomson Corporation is our source on this matter.

Inputs and their measurement

As in many studies on efficiency in education (see section 1.2), the number of full-time equivalent academic staff is the input considered. This category includes all personnel whose primary or major assignment is instruction or research (covering, namely, those holding an academic rank with such titles as professor, associate professor, assistant professor, instructor, lecturer, or the equivalent of any of these academic ranks). Ideally, we would also like to consider non-academic staff, whose main function is to administer students, teachers, and researchers and who facilitates the teaching and research process in general, as well as the

[2] See, for example, Flegg *et al*. (2004).

[3] The Institute of Higher Education from the Shanghai Jiao Tong University also produces a well known world ranking of universities. We did not use data from that ranking because it would imply a double counting in what concerns publications and citations. On the other hand, the qualitative survey data we took from the THES-QS ranking is not superimposing to the information we collected from other sources.

total time spent by students in order to have a degree, and some measure of the physical capital used (e.g., buildings and libraries). Nevertheless, such data is not available for most countries/years comprised in this study.

The total number of students is the other input we included. Students are an input in so far as they constitute the essential resource used to produce one of the main tertiary education outputs – the number of graduates. Implicitly in our approach, students who do not achieve graduation are an indicator of waste in education, as time, labour, capital, and expectations were spent without a measurable outcome.[4]

Cost (money) measures

In order to implement a multi-dimensional cost function model, we have to consider the total cost of the tertiary educational system. In one model,[5] we have considered wages in the services sector as a proxy for wages in tertiary education across countries, so we could have data for the whole sample. Other alternatives proved less adequate:

- Dividing staff costs by the number of full-time equivalents in the Unesco/OECD/Eurostat database was considered, but missing values are too numerous.

- The International Labour Organization (ILO) collects information on wages paid in the month of October to tertiary education teachers of mathematics or languages and literature, but we could not use it for several reasons: the data do not capture variation in the number of months paid each year, nor in employers' social security contributions and missing values are very numerous. Moreover, the ILO makes very few adjustments to the national replies to the questionnaires provided.

- Eurostat has data on average annual gross earnings in education. However, apart from neglecting social security contributions paid by employers (and, of course, comprising non-tertiary education), this variable presents missing values in all years for more than half of the countries in our sample. Eurostat also has annual information on monthly labour costs in education, with somewhat better country coverage (only 5 EU members without any annual entries), though often with very short time spans (e.g., countries with data for only 2 or 3

[4] As mentioned in section 1.2, some studies on university efficiency follow our approach (for example, Flegg *et al*., 2004). Others, however, consider the number of students as an output, rather than an input (for example, Abbott and Doucouliagos, 2003). We think there is an essential distinction between enrolled students as such, who are simply working to achieve a goal, and graduates, students who have achieved that goal. Assuming enrolled students as an output would result in a bias towards efficiency for those systems where drop out rates are high and we wish to consider this as a waste symptom.

[5] Wages were considered in the "alternative SFA model;" see Appendix E.

years). We have checked that the available observations are highly correlated with our chosen proxy (even when "old" and "new" Member States are considered separately), which suggests that the use of the latter does not distort significantly the analysis.

Exogenous and environment factors

These are factors that potentially determine efficiency scores. In Figure 1, exogenous and environment factors explain in part why the DMU D is below the production possibility frontier. One could for example expect that under a less adverse environment DMU D could have been found producing d_{1c} instead of d_1.

These variables are to be introduced in both efficiency measurement models to be used (two-stage DEA and SFA), as explained in the proper sections. Here, we make reference to the most likely factors and corresponding variables that may be found to be significant:

i) Universities' organisation and funding schemes

The way universities are organised is probably the first factor that comes to mind in what concerns explaining inefficiencies. We consider institutional indicators taken from Oliveira Martins *et al*. (2007). These authors constructed a composite indicator from a questionnaire in such a way that low values are associated to input rigidity, supply restrictions, and absence of accountability and high values linked to input flexibility, no supply restrictions, and high accountability.[6]

ii) Quality of secondary education

As in most countries the majority of the tertiary students have obtained their secondary degrees in that very same country, it is possible that better quality in secondary education affects efficiency in tertiary education. Examples of measures of secondary education quality are PISA scores, which we include here, and drop out rates.

Definition of effectiveness and outcomes

While efficiency derives from a relationship between inputs and outputs, and refers essentially to the extent to which outputs are attained while minimising production costs, effectiveness refers, in our view, to the connection between inputs, outputs and more general,

[6]The questionnaire used to build the composite indicator is available in Appendix C.

second layer type objectives or outcomes. According to this preferred definition, while outputs from tertiary education are graduated students or published papers, outcomes to which these outputs in principle concur may be higher productivity, employability, innovation, or economic growth.

Outcomes to be considered

When considering effectiveness of tertiary education across countries, we will be asking the following questions:

i) Are increasing tertiary education spending levels affecting in a positive way labour productivity or total factor productivity?

ii) How does efficiency in tertiary education promote employability? Namely, does efficiency explain the gap between graduates' unemployment rate and that of people with secondary education only?

iii) And how does efficiency in spending affect the relationship between tertiary education spending and labour productivity?

1.2 A literature survey

Despite the long history in studying universities costs, it is only recently that it is taken into account the presence of inefficiency in university production. In fact, while previous work in general assumed that the university produces on the minimum-cost frontier, recent empirical analysis allows for inefficiencies using two main categories of methods, namely, DEA methods and SFA.

The scope of most of these studies, with only a few exceptions, is limited to the higher education institutions of a single country and the approaches are varied. Firstly, the output of universities can be generally categorized into teaching and research. Some works focus only on one of these dimensions, while others cover both. Second, concerning the choice of outputs and inputs, there is no definitive study to guide the selection of these factors in educational application. Various variables have been employed as measures of teaching output. The number of degrees conferred, the number of graduates, or full-time equivalent student enrolment are the most common, with, eventually, a distinction between the undergraduate and the graduate level and arts and sciences. There is no reason why students

should be considered a better measure than the number of graduates: degrees awarded neglect the education of those who attend but do not graduate, but measure completions and the level of accomplishment. McMillan and Datta (1998) use the full-time equivalent number of students. A study that uses the number of graduations as a measure of outcome is Abbott and Doucouliagos (2003), whereas Athanassopoulos and Shale (1997) employ the number of graduates; Johnes (2006) and Flegg *et al*. (2004) divide the number of degrees awarded in graduate and postgraduate degrees; Warning (2004) distinguishes between graduations in sciences and in social sciences. Adjustment for quality is rare, namely through peer evaluation, given the lack of consistent qualitative measures in higher education. Both Flegg *et al*. (2004) and Johnes (2006) aim at evaluating universities in the UK and use graduations weighted by degree classification.

The means for estimating the value of the research output is not less controversial. It has been assessed by means of the number of patents obtained, as well as publications and citations (see Athanassopoulos and Shale, 1997, and Warning, 2004). An alternative approach is to use government or external research finance attracted by a university as a proxy for both quantity and quality of the research output, even though some argue that this may well be considered an output, instead of an input. This is the case of Abbott and Doucouliagos (2003), Flegg *et al*., or McMillan and Datta (1998).

If there is no consensus on which output measures to use and, in many cases, output selection is driven by the availability of reliable data, inputs are more readily quantifiable. Since university inputs must be purchased, expenditure becomes an aggregate input measure (see Athanassopoulos and Shale, 1997). Faculty are typically incorporated in full-time equivalent numbers or as salary expenses. This may be extended to include all academic staff or even non-academic staff, again in numbers or costs. Abbott and Doucouliagos (2003), Johnes, 2006, and Flegg *et al*., 2004 consider staff in numbers and Warning (2004) in costs. Other separately designated inputs are the full-time equivalent number of students (see Flegg *et al.*, 2004, and Johnes, 2006), expenditure on inputs other than labour inputs, and proxies for the university's capital stock. Johnes (2006) for instance, uses the value of interest payments and depreciation as a measure of the capital stock.

All the aforementioned studies apply DEA to study efficiency in the higher education sector; other examples include Tomkins and Green (1988), Beasley (1990, 1995), Johnes and Johnes

(1993), Sarrico *et al*. (1997), Sarrico and Dyson (2000). Among the few articles that apply SFA to higher education, we only mention two key studies, both concerning universities in the UK. Izadi *et al*. (2002) estimates a constant elasticity of scale (CES) cost frontier. The dependent variable is total expenditure and the independent variables are the number of undergraduate students in arts and in sciences, the number of graduate students, and the value of research grants received. Apart from these, Stevens (2005) also considers staff costs and, in order to account for the quality of the teaching output, the proportion of first-class degrees, while controlling for input quality by means of the average scores of students entering the university.

To the best of the authors' knowledge, attempts to make efficiency analysis of the higher education sector at the international level are only a few. Joumady and Ris (2005) compare universities in 8 different countries (Italy, Spain, France, Austria, Germany, the Netherlands, United Kingdom, and Finland), using a large sample of recent higher education graduates responses to a survey conducted in 1998. Their aim is to evaluate the adequacy of the skills of recent graduates from different universities to the labour market requirements. Thus, they focus on teaching and define efficiency as the ability to, first, generate human capital competencies and, second, to match the competencies provided with the competencies required, and outputs are taken along these lines. Inputs are students' qualification and grade before enrolment in higher education, study conditions and teaching quality provision, and intensity of job search. By computing average efficiency scores, Joumady and Ris (2005) distinguishes between three groups of countries, namely the UK, Netherlands, and Austria, that have relatively good performance, France and Germany, that are located on an average level of inefficiency, and finally, Spain, Finland, and Italy, that exhibit the worst performances.

Agasisti and Johnes (2007) use DEA to compare technical efficiency of English and Italian universities in the period 2002-3 to 2004-5. This study includes as outputs the number of graduates and the total amount of external grants and contracts for research, thus covering both dimensions - teaching and research. As inputs, they consider the total number of students, the total amount of financial resources/incomes, the number of PhD students, and the number of academic staff. By looking at the evolution of technical efficiency scores over the four-year period, Agasisti and Johnes (2007) conclude that whereas Italian universities are improving their technical efficiency, English universities are obtaining stable scores.

Nevertheless, the typical English HE institution is measured as being much more efficient than its Italian counterpart. Finally, Agasisti (2008) is the only article that performs a cross-country comparison using countries as decision-making units. It conducts a DEA on the HE sector of some European countries for the period 2000-2003, focusing on the teaching dimension only. Agasisti uses as outputs the population that has attained tertiary education, employment rates of graduates, and the percentage of foreign students. Inputs are the students to teachers ratio, entry rates, and expenditure on educational institutions. Agasisti then concludes that the UK has the best performance, essentially due to the high graduation rates experienced and the good results in terms of foreign students' attraction. France, Germany, and Ireland also display good performances. The Nordic countries are characterized by relatively low efficiency scores given the extremely high levels of spending, while Eastern countries have both relatively low levels of spending and low performances, except for the Slovak Republic, which results as an efficient country.

In what effectiveness is concerned, there is a vast literature studying the impact of education on economic growth, though many contributions do not disaggregate education by levels, so as to study the importance of *tertiary* education. Abundant research is also available on the link between education and labour market outcomes, though often drawing on micro data. Our survey of these strands of literature will be selective, and mainly guided by the approach taken in section 3 of this report.

Some studies address the importance of education for output or productivity growth within the more general framework of the growth effects of fiscal policy, especially of public expenditure and its composition. From this perspective, one tests the explanatory power of public spending on education in a growth regression, controlling for other variables, such as capital accumulation, initial income levels or other budget items. Examples include Blankenau *et al.* (2007) and Devarajan *et al.* (1996). The latter study contains a detailed disaggregation of central government expenditure, including, among many other categories, tertiary education spending (for which no significant beneficial growth effects were found).[7]

[7] The sample period is 1970-1990 and the study draws on data from the IMF's *Government Finance Statistics*. In past issues of this source total education outlays were broken down into schools, universities and other spending, but this disaggregation has been discontinued.

While the approach in the previous paragraph can be regarded as input-based, it is also possible to consider how education outputs contribute to economic growth. By far the most widely used output is average years of schooling, which is taken as a proxy for human capital and included in a production function alongside other production factors, such as labour and physical capital (see, e.g., De la Fuente and Domenech, 2006; Cohen and Soto, 2007). A few studies disaggregate total human capital by levels of education –e.g., Pereira and St. Aubyn (2008) or Vandenbussche *et al.* (2006), the latter study suggesting that the growth effects of tertiary education are stronger the closer economies are to the technological frontier. For the purposes of the present report, however, a disadvantage of this approach is that it neglects one of the main outputs of tertiary education, namely scientific research.

It holds that in most countries and years schooling minimizes the risk of unemployment, and hence the unemployment rate among those with tertiary education attainment is smaller than among groups with lower levels of attainment (see, e.g., Blondal *et al.*, 2002). On the basis of micro data (individual-level data from household surveys), Boarini and Strauss (2007) estimates for several countries the employability premium from tertiary education (relative to upper secondary education) controlling for other individual characteristics, and find an average value of roughly two percentage points. Biagi and Lucifora (2008) studies the impact of education on unemployment using data from Labour Force Surveys for 10 European countries, and conclude that, controlling for a host of other factors (e.g., demographic variables or the business cycle), higher educational attainment (measured by the share of those with more than primary education) reduces unemployment rates, both for less educated and (especially) for more educated groups. In section 3 of this report we intend to go one step further and investigate the determinants of cross-country variation in the employability premium from tertiary education.

1.3 Data

Data on inputs, teaching outputs, and financial data were drawn from the OECD (Online Education Database) whenever possible to ensure data comparability across countries. Such data are available for the period 1998-2005 only, thus considerably restricting the scope of our study. Moreover, in order to derive consistent time series for the period considered, the

OECD data were combined with other sources, notably Eurostat.[8] In what research outputs are concerned, the ISI Web of Science was the main source. Finally, indexes on the quality of teaching were drawn from THES (Times Higher Education Supplement), the institutional variables were taken from Oliveira Martins *et al.* (2007), and macroeconomic data from AMECO and Eurostat. Precise definitions of the variables used are given in what follows. Appendix A contains the data and details on sources and some remarks are available in Appendix B.

Input data

Academic staff:

Definition: Number of members of the academic staff (comprising all personnel whose primary or major assignment is instruction or research and so covers personnel who hold an academic rank with such titles as professor, associate professor, assistant professor, instructor, lecturer, or the equivalent of any of these academic ranks), working in both PGD institutions of tertiary education (including ISCED levels 5 and 6) in full-time units.

Students in PGD Institutions:

Definition: Number of students enrolled in PGD institutions of tertiary education (ISCED levels 5 and 6) in full-time units.

Expenditure/financial data

Total Expenditure on PGD Institutions in Percentage of GDP:

Definition: Annual expenditure on PGD institutions in percentage of GDP at tertiary level of education (ISCED levels 5 and 6).

[8] We think it is important to point out that UOE databases on education are incomplete, with a good number of missing figures and unclassified items. Apart from measurement errors, this conditioned our empirical work when it came to model specification and periods considered in a manner that will be clarified in the following parts of this report.

Total Expenditure on PGD Institutions in Purchasing Power Standard in Real Terms *Per Capita*:

This data has been constructed using the dataset *Expenditure by nature and resource category* from the UOE data collection. We have obtained the total current and capital expenditure for PGD institutions for the selected years. Originally data is measured in millions of national currency and, for the sake of comparison, we have transformed the data into purchasing power standard euros in real terms using the following formula:

$$\frac{TotExp_{ti}}{Pop_{ti}} \times \frac{1}{E_{ti}} \times \frac{1}{PPS_{ti}} \times \frac{1}{D_{ti}},$$

where $TotExp_{ti}$ is the total current and capital expenditure in million of national currency for country *i* in year *t*; Pop_{ti} is the total population; E_{ti} is the ECU-EUR average exchange rates defined as units of national currency *per* EUR/ECU; PPS_{ti} is the ratio of GDP purchasing power parities over ECU/EUR exchange rates and, finally, D_{ti} is the euro area price deflator of the gross domestic product at market prices of the year 2000. Data on Pop_{ti}, E_{ti}, PPS_{ti}, and D_{ti} has been obtained from AMECO Database.

Total Public Expenditure on Tertiary Education

Definition: Annual expenditure on tertiary education by all government levels, consisting of direct expenditures for educational institutions (public and private) plus transfers and payments to private entities (i.e., public spending outside educational institutions).

Total Public Expenditure for Educational Institutions (Tertiary Education)

Definition: A component of the preceding variable.

Output data

Graduates in PGD Institutions:

Definition: Number of students who graduate in PGD institutions of tertiary education (ISCED levels 5, 6).

THES - QS recruiter survey ranking:

Definition: Classification of world universities according to results from a survey filled by recruiters from all over the world (2005, 2006, and 2007) and concerning the employability of graduates.

THES - QS peer survey ranking:

Definition: Classification of world universities according to results from a survey filled by academics from all over the world (2005, 2006, and 2007).

Published articles:

Definition: Number of published articles in a given year with at least one author affiliated to a given country's institution and included in the ISI Web of Science database. The data collection methodology was the following. Firstly, we obtained a list of the PGD institutions for each country. Then, for each year and each country, we searched all publications for which at least one author was affiliated to an institution of that particular country. From these, we selected the publications from the universities belonging to the relevant list, i.e., the list of the PGD institutions. The ISI platform does not allow for searches in which the number of publications in one year exceeds 100 000. In cases where that situation arose, namely the US, we have split the search into the different states and then removed the papers that included authors in more than one state, to avoid double counting of these publications.

Citations:

Definition: Number of citations of articles published and cited within a five-year period with at least one author affiliated to a given country's institution and included in the ISI Web of Science database. The data collection was done as follows: after having obtained the list of relevant institutions in each country, we looked for the number of citations of papers published in a certain year in the five subsequent years, whenever possible. Whenever the number of publications of a country exceeded 10 000, in which case the ISI platform does not return any valid number, we partitioned that country’s set of institutions so as to obtain groups of institutions that publish at most 10 000 articles per year. We then obtained all citations for

the publications of each group of institutions, excluding those already considered in a different group to avoid double-counting, and summed them up to obtain the number of citations of the country's publications.

Institutional and environment data

Supply of tertiary education (STE)

Definition: STE is a composite indicator of the institutional set-up of tertiary education, aggregating scores for input flexibility, output flexibility, and accountability.

Input flexibility (IF):
i) Selection of students: autonomy to choose the number of students and their profile.
ii) Budget autonomy: autonomy to decide on the level of tuition fees and to raise other funds, as well as to decide on the structure of expenditure.
iii) Staff policy: autonomy to hire, set the wages, and to dismiss the academic staff.

Output flexibility (OF):
Autonomy to set course content, to offer more diversified studies, and to decide on the (in)existence of constraints associated with *numerus clausus*.

Accountability (Ac):
i) Evaluation: presence of an independent evaluator, involvement of stakeholders in the evaluation process, and availability of public evaluation reports.
ii) Funding rules: input or output-oriented funding.

PISA

Definition: PISA is an internationally standardised assessment that was jointly developed by participating countries and administered to 15-year-olds in schools. The survey was implemented in 43 countries in the first assessment in 2000, in 41 countries in the second assessment in 2003, and in 57 countries in the third assessment in 2006. Tests are typically administered to between 4 500 and 10 000 students in each country. We have considered the

average of the PISA assessments on reading, mathematics, and science in year 2000 as a measure of the student preparation for university studies.

1.3 Preliminary analysis

FIGURE 2

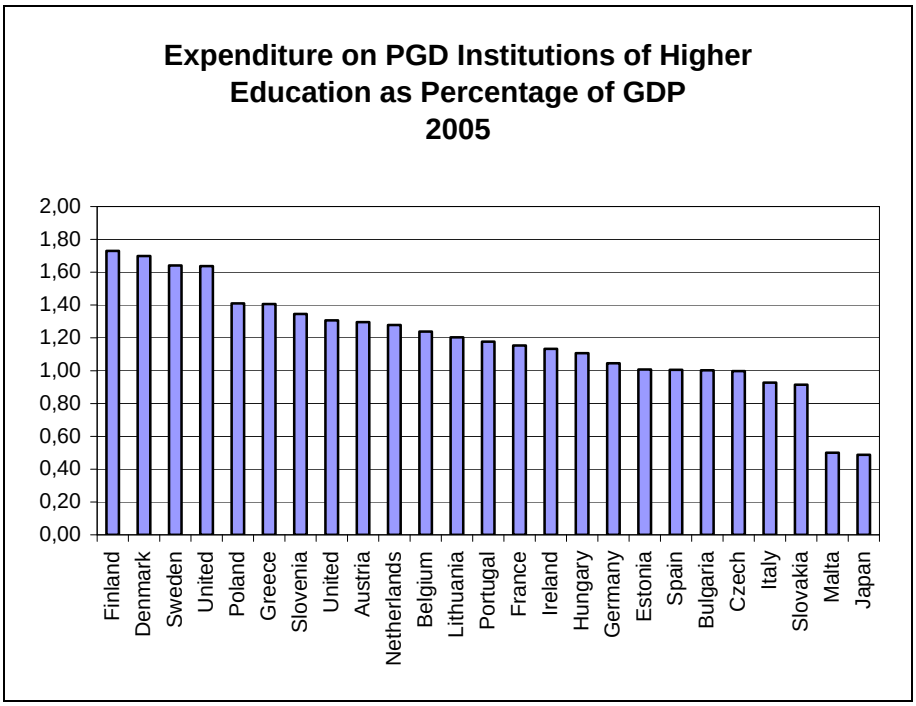


Figure 2 expresses the total public expenditure on tertiary education institutions in percentage of GDP in 2005. It varies from 1.73% (Finland) to 0.49% (Japan). The average is 1.2%.[9]

Figure 3 illustrates the number of academic staff in PGD institutions relative to the total country population. This number varies between 3.7 (Sweden) and 0.8 (Japan). Romania has the lowest figure available for a EU country, 1.1. Notice that Sweden and Finland have a very high number of academics per 1000 inhabitants whereas the UK is below average. Also striking are the cases of Bulgaria, Estonia, and Spain with values well above the average (2.0).

[9] Note that, in total, the US expenditure on education is much higher than European countries' expenditure, but this is mainly due to private funding.

FIGURE 3

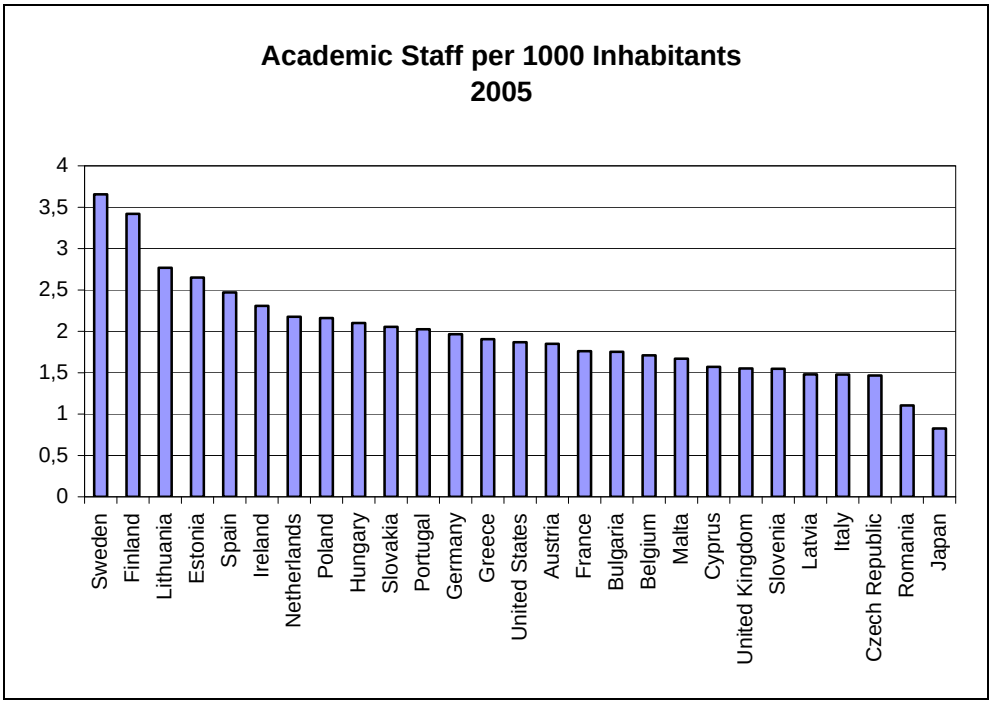
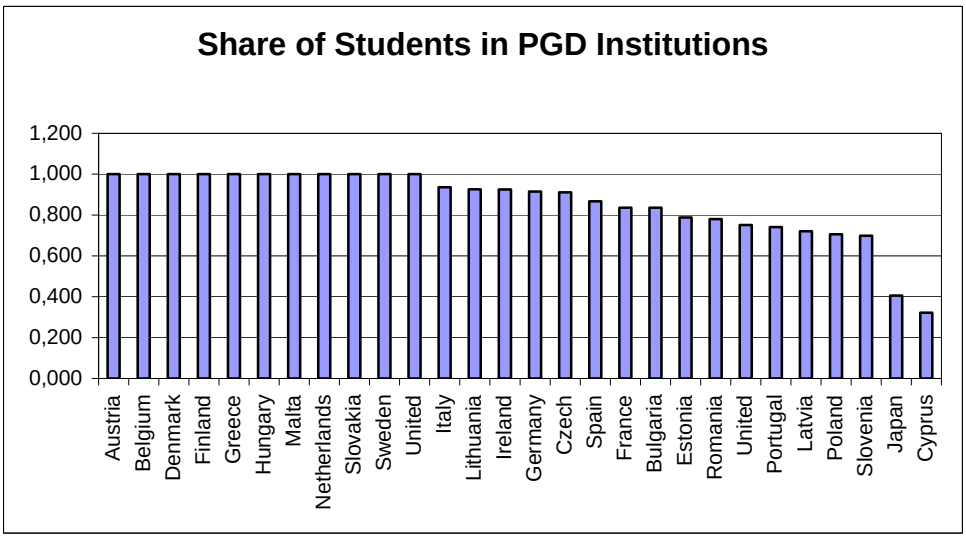


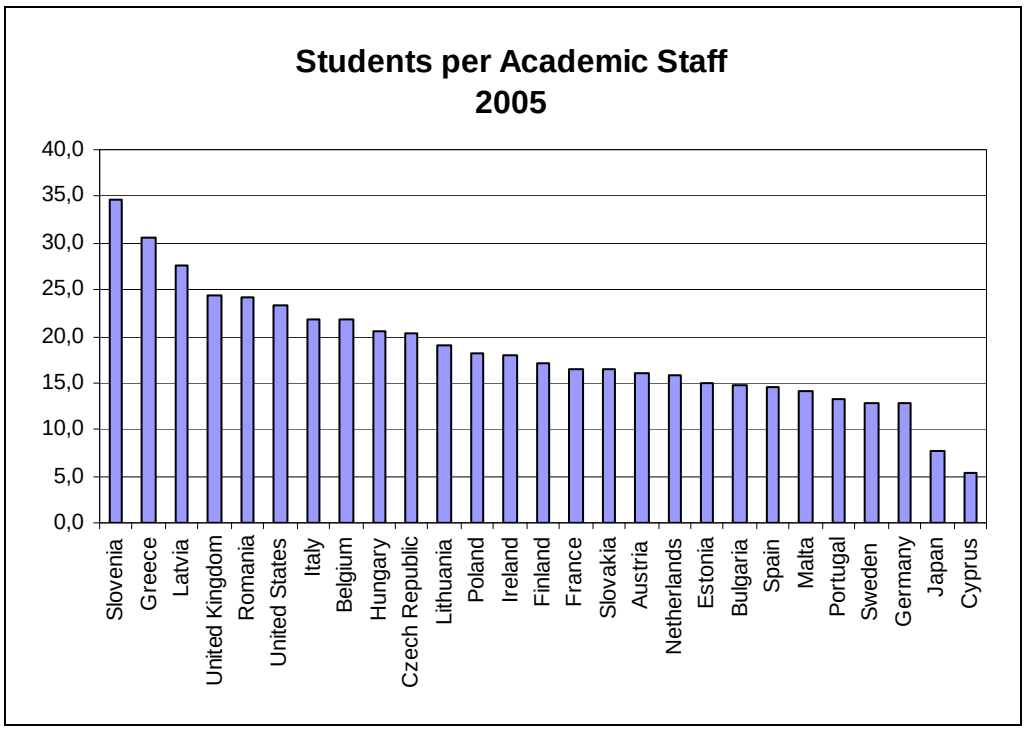
Figure 4 depicts the share of students in the tertiary education enrolled in PGD institutions. Note that the countries in which 100% of the students are enrolled in these tertiary education institutions are countries in which there are no private independent universities, or in which these institutions are very small (Austria). Observe that in the analysed countries the weight of the public sector in tertiary education is very high, except for Japan, in which only 21% of the students are enrolled in public tertiary education institutions.

FIGURE 4



The number of students in ISCED levels 5 and 6 per member of the academic staff is illustrated in Figure 5. Slovenia has a very high ratio of students per member of the academic staff (35), whereas Japan and Cyprus have a much lower ratio (7.8 and 5.4, respectively).

FIGURE 5



In terms of graduations (Figure 6 and Figure 7) we observe that Ireland, Lithuania, and the UK have a good performance both in the number of graduates per 1000 inhabitants and per member of academic staff. We observe a high variance across countries (see Figure 7). The worst performances in Europe are from Austria, Germany, and Cyprus, with a very low number of graduates.

FIGURE 6

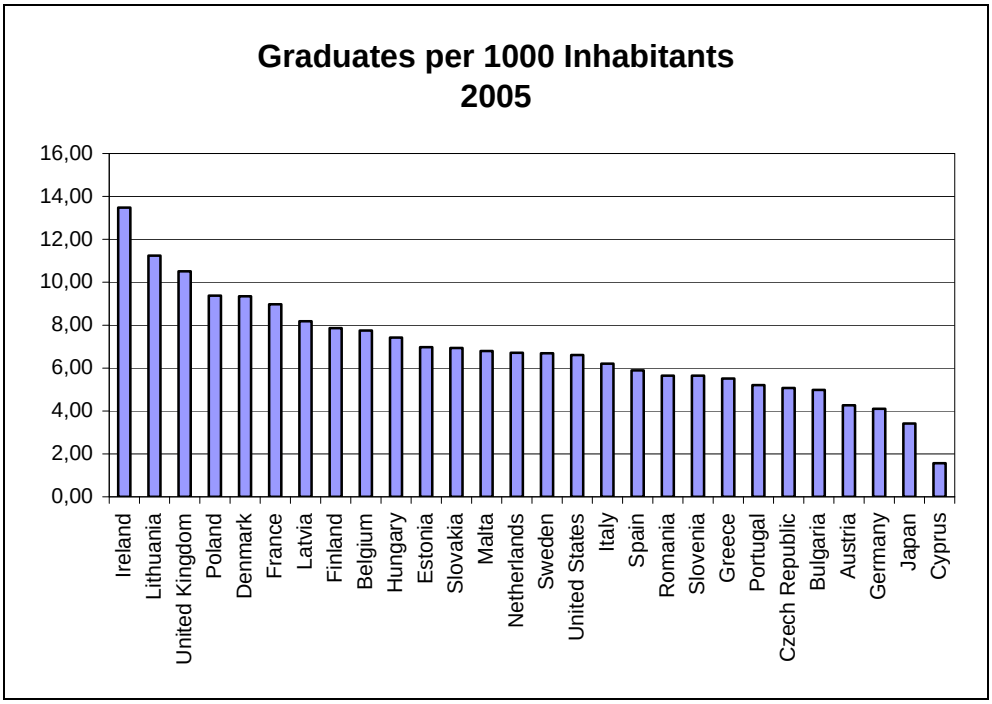
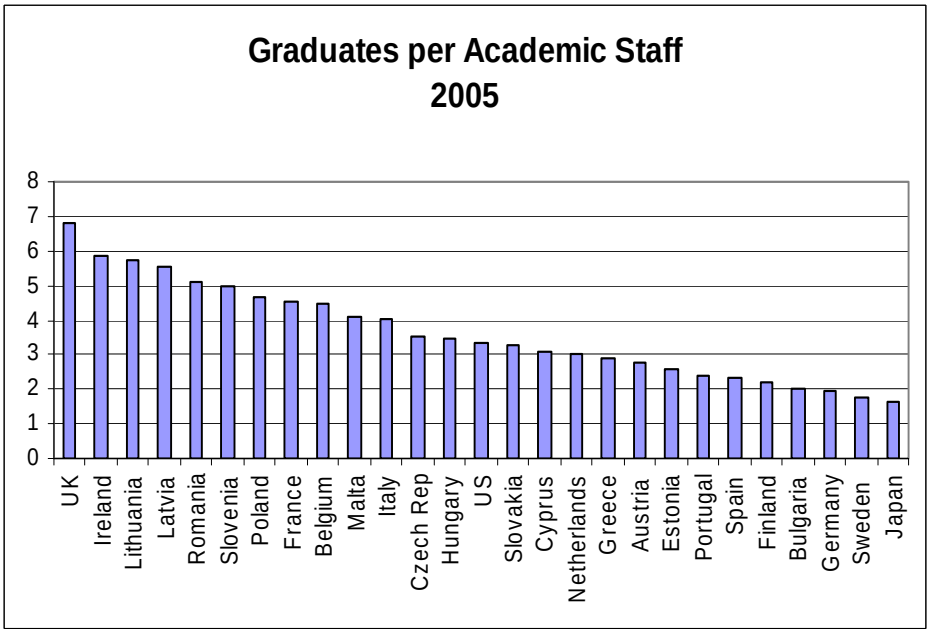


FIGURE 7

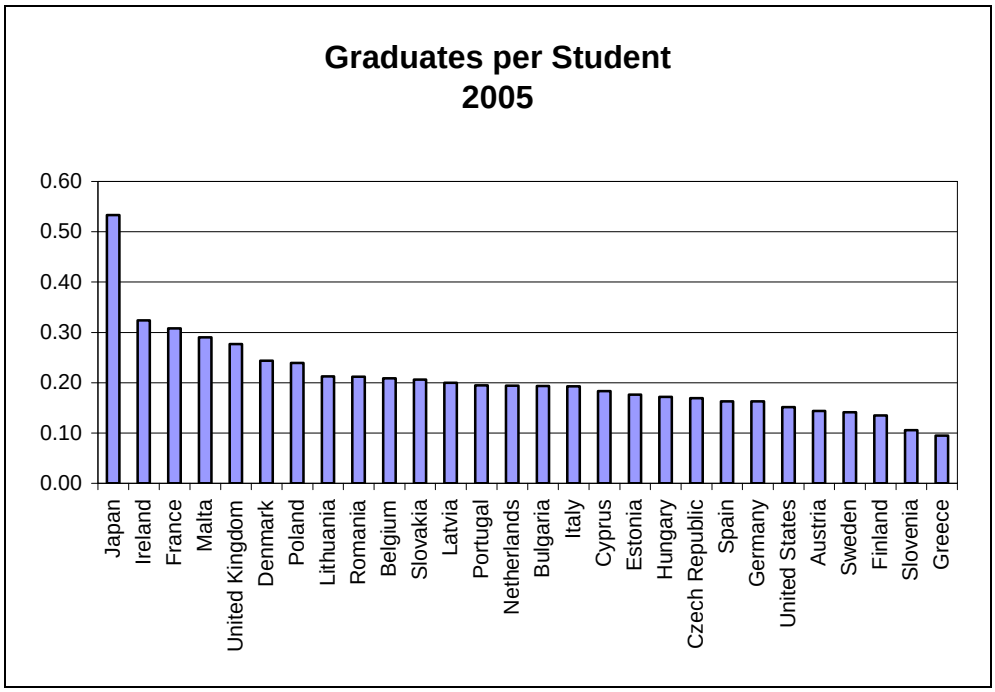


Note that the indicator "graduates per academic staff" can be used to analyze the efficiency of the teaching system as graduates are one of the outputs of tertiary education and academic staff is one of the inputs. In Figure 7 we observe that, on average, the number of graduates per academic staff is between 3 and 4, but some countries can achieve twice this value. It will be interesting to compare the number of publications per academic staff and the number of

graduates per academic staff given that these are the two outputs of the tertiary education system.

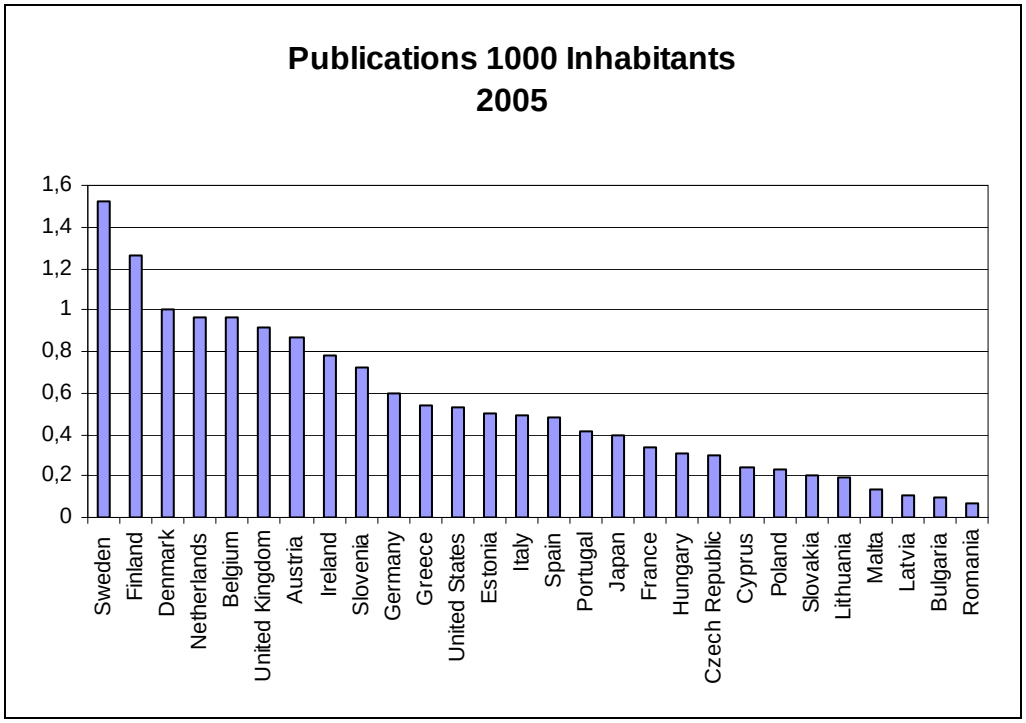
Another important indicator is the graduation rate, defined as the percentage of graduates over the number of students in each period. It can be interpreted as a turnover rate of tertiary education. This variable can be observed in Figure 8.

FIGURE 8



The number of published articles is one possible measure of scientific production. This measure is plotted in Figure 9. Again, this number is divided by the population to scale the indicator.

FIGURE 9



Scientific production as measured by the indicator in Figure 9 is particularly high in the Nordic countries (Sweden, Finland, and Denmark) and the Netherlands. Note that all these countries are above the US, the greater producer in absolute terms.

It is possible to decompose the number of articles *per capita* in two other interesting indicators, the number of articles per member of the academic staff, and academic staff *per capita*:

$$\frac{number\ of\ articles}{population} = \frac{number\ of\ articles}{academic\ staff} \times \frac{academic\ staff}{population} \quad . \qquad (1)$$

Articles' production *per capita* depends both on the academic staff productivity and on the relative importance of the academic staff respective to total population. As it will be shown in the following lines, this decomposition allows a deeper analysis of differences across countries.

TABLE 3: DECOMPOSITION OF THE PRODUCTION OF ARTICLES 2005

	Articles per 1000 Inhabitants	Articles per Academic Staff	Academic Staff per 1000 Inhabitants
Austria	0.87	0.47	1.85
Belgium	0.96	0.56	1.71
Bulgaria	0.09	0.05	1.75
Cyprus	0.24	0.15	1.57
Czech Rep	0.30	0.21	1.47
Estonia	0.50	0.19	2.65
Finland	1.26	0.37	3.42
France	0.34	0.19	1.76
Germany	0.59	0.30	1.96
Greece	0.54	0.28	1.91
Hungary	0.31	0.15	2.10
Ireland	0.78	0.34	2.31
Italy	0.49	0.33	1.48
Japan	0.40	0.48	0.83
Latvia	0.10	0.07	1.48
Lithuania	0.19	0.07	2.77
Malta	0.14	0.08	1.67
Netherlands	0.96	0.44	2.18
Poland	0.24	0.11	2.16
Portugal	0.42	0.21	2.02
Romania	0.06	0.06	1.10
Slovakia	0.20	0.10	2.05
Slovenia	0.72	0.46	1.55
Spain	0.49	0.20	2.47
Sweden	1.52	0.42	3.66
UK	0.92	0.59	1.55
US	0.53	0.28	1.87

Table 3 displays the aforementioned decomposition across countries in 2005. Some countries are not included due to missing data. The following observations apply:

- the countries with the highest production *per capita* (Finland and Sweden) are also countries with a large academic staff. Productivity of this academic staff is above average;
- some countries achieve above average production *per capita* (the Netherlands and the UK) essentially due to a high academic staff productivity, while displaying a smaller than average academic staff;
- a third group of countries, while employing an above average academic staff, produces below average. This group includes Spain, Portugal, Hungary, Slovakia, Estonia, Poland, and Bulgaria;

- finally, some countries not only exhibit lower productivity, but also have a relatively small academic staff. This is the case of Romania, Latvia, Malta Cyprus, and Czech Republic.

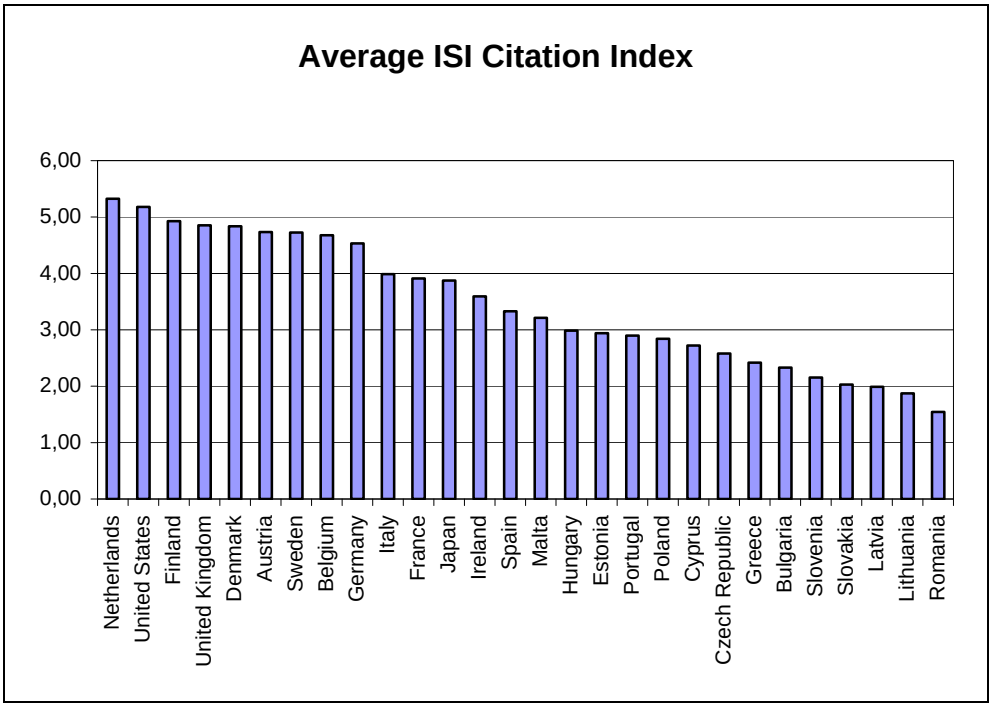
The number of times an article is cited by another article constitutes a usual measure of its impact. The average number of citations per article is one possible measure of the quality of a country's scientific production. We have computed a citation index based on the data available on the ISI Web of Knowledge:

$$Index\,Cit_{t,t+4} = \frac{\sum_{k=t}^{t+4} cpub_k}{\sum_{k=t}^{t+4} pub_k}, \text{ for } t=1998,\ldots,2001, \qquad (2)$$

where $cpub_k$ represents the number of citations in year k and pub_k is the number of publications in year k.

Figure 10 exhibits the average of the Citation Indexes for the different periods.

FIGURE 10



It is worth to highlight countries such as the Netherlands, the US, Finland, and Sweden, which not only produce a high number of publications, but also have a high impact in terms of citations. Eastern European countries exhibit a weaker performance.

Two other quality indicators, the peer review and the recruiter view country indicators, were constructed from the THES - QS World University Rankings database.

The peer review country indicator intends to reflect each country's presence in the universities' ranking derived from the THES - QS peer survey. In order to compute a score for each country, we have considered only PGD universities and given points according to the following rule:

- 2 points for each university between the 1st and the 100th position;
- 1.5 points for each university between the 101st and the 200th position;
- 1 point for each university between the 201st and the 300th position;
- 0.5 points for each university between the 301st and the 400th position.

We have then summed all the points corresponding to each country's institutions and obtained a score per country.

The peer review country indicator results from the adjustment of this score for country size, taking into account the weight of PGD institutions in tertiary education. To be precise, the country score was divided by population multiplied by the proportion of students in PGD institutions:

$$peer\ review\ country\ indicator = \frac{country\ score}{population \times \frac{students\ in\ PGD\ institutions}{total\ number\ of\ students\ in\ tertiary\ education}} \times 10^8.$$

Then, this indicator has been standardised using the following procedure:

$$std.\ peer\ review indicator = \frac{peer\ review country\ indicator}{Highest\ peer\ review country\ indicator} + 1. \qquad (3)$$

The recruiter review country indicator aims to reflect graduate employability. It is derived from the THES - QS recruiter survey. Its computation follows the same method as the peer review country indicator.

In Figure 11 we plot the standardised recruiter review country indicator. Recruiters regard the Universities in Ireland and in the UK as providing highly employable graduates. On the other hand, Spanish, Polish, and Portuguese universities perform poorly on this strand. Other countries, for which the standardised recruiter review country indicator equals 1, do not have any university in the top 400.

The standardised peer review country indicator is depicted in Figure 12. Considering their size, Finland, Ireland, and Sweden are the countries with more universities pointed out by peers as being excellent. Spain, Poland, and Greece also perform poorly on this indicator, but note should be taken that some countries were not included in the graphs because their score was null.

FIGURE 11

FIGURE 12

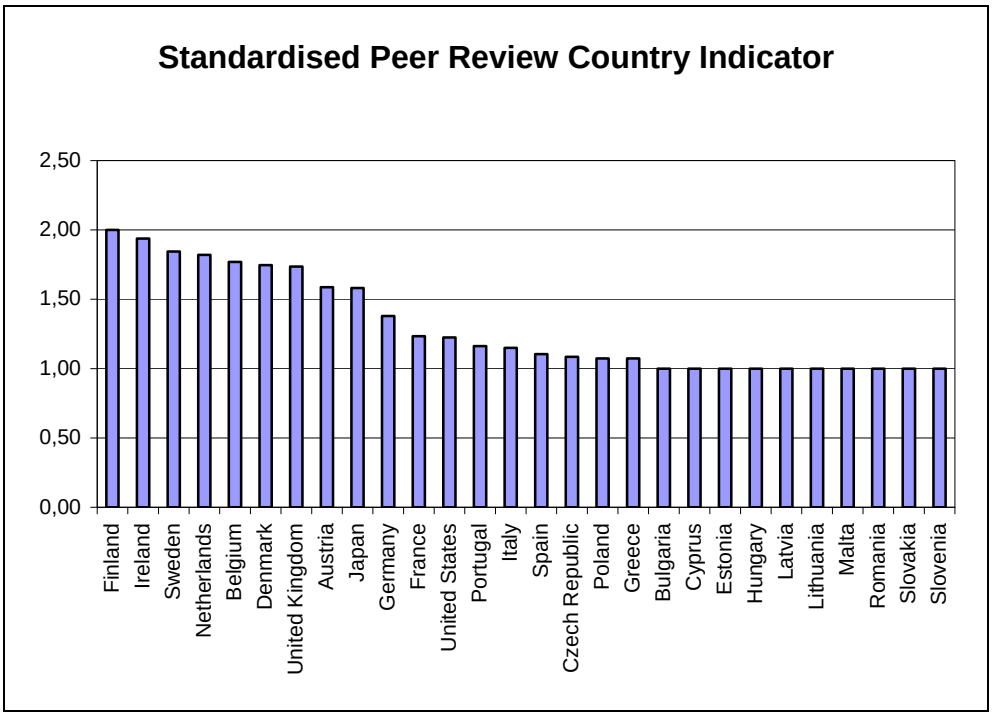
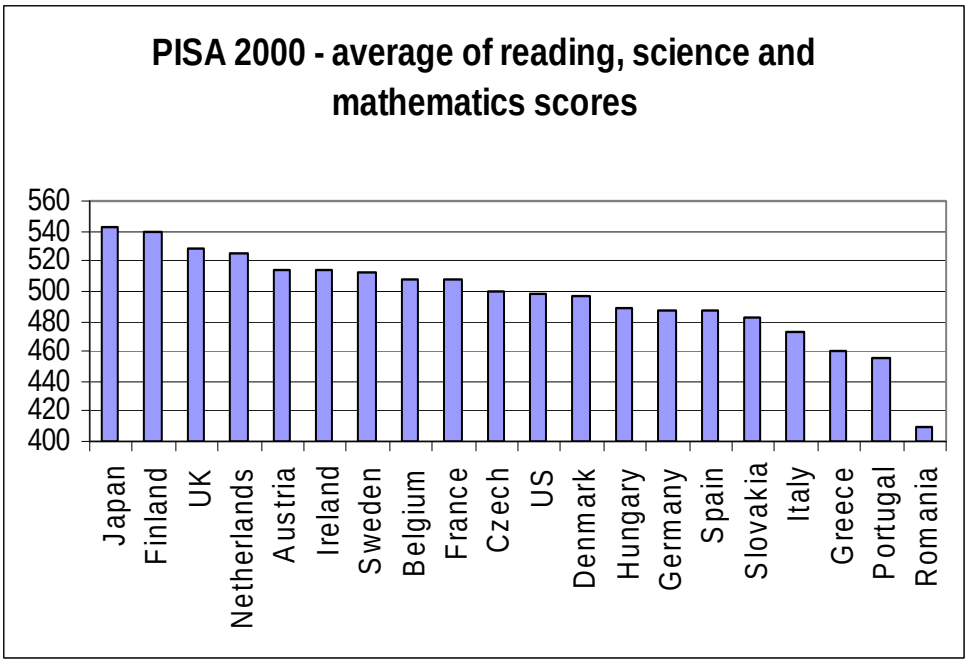
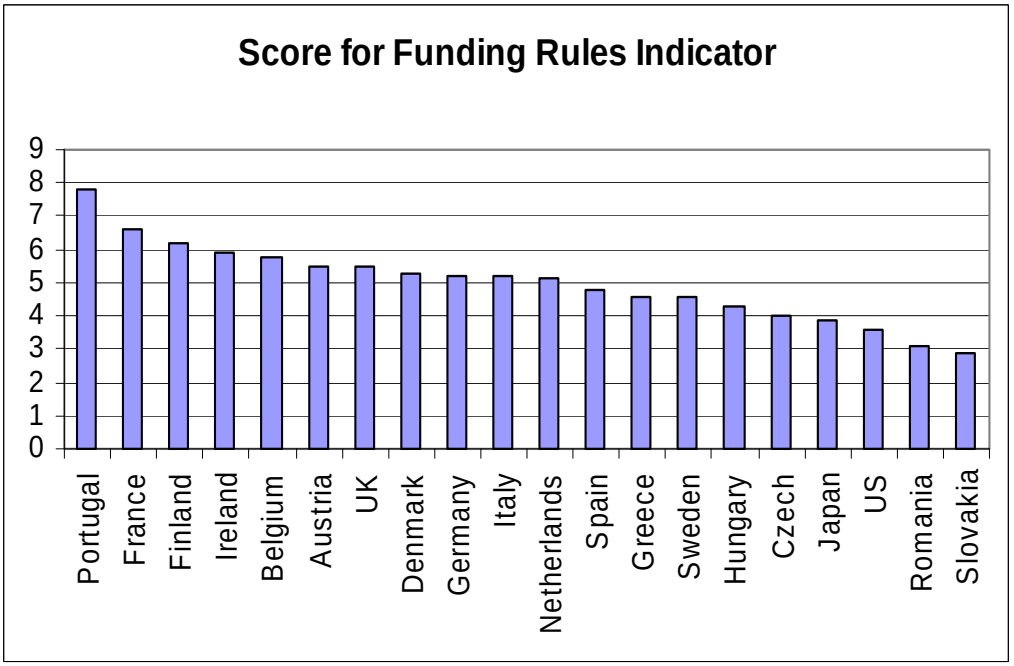


FIGURE 13



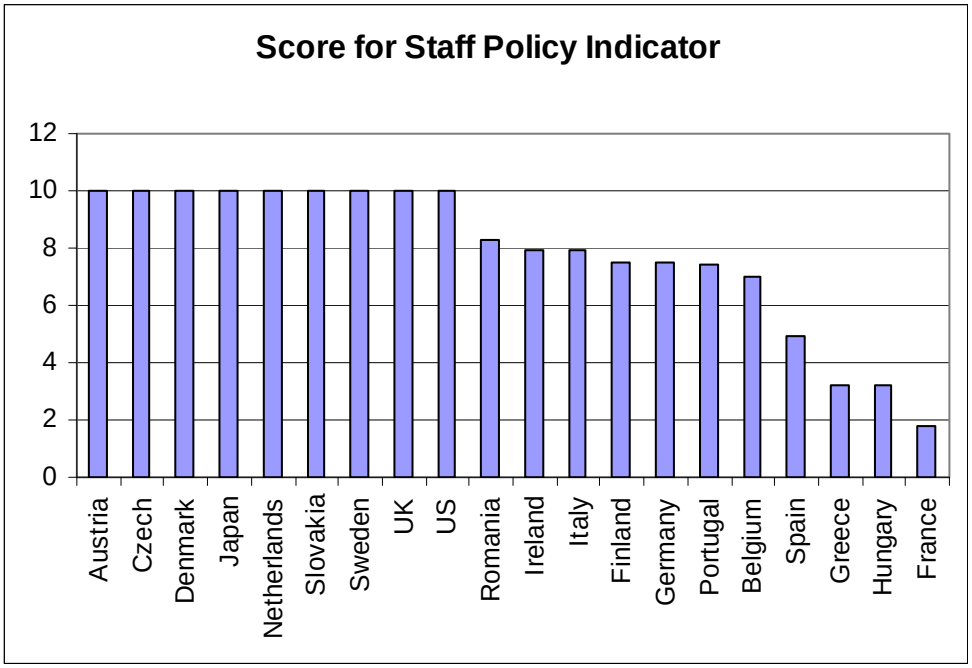
The average of the PISA indicator is 496.6. The highest scores are attained by Japan, Finland, the UK, and the Netherlands. The US have a slightly above average score and the lowest scores belong to Greece, Portugal, and Romania.

FIGURE 14



Portugal performs extremely well in the Funding Rules indicator. The average of this indicator is 5. The worse performing countries are Romania and Slovakia.

FIGURE 15



Several countries attain the maximal value for the staff policy indicator, namely Austria, Czech Republic, Denmark, Japan, the Netherlands, Slovakia, Sweden, the UK, and the US. The lowest score is for France followed by Hungary, Greece, and Spain.

FIGURE 16

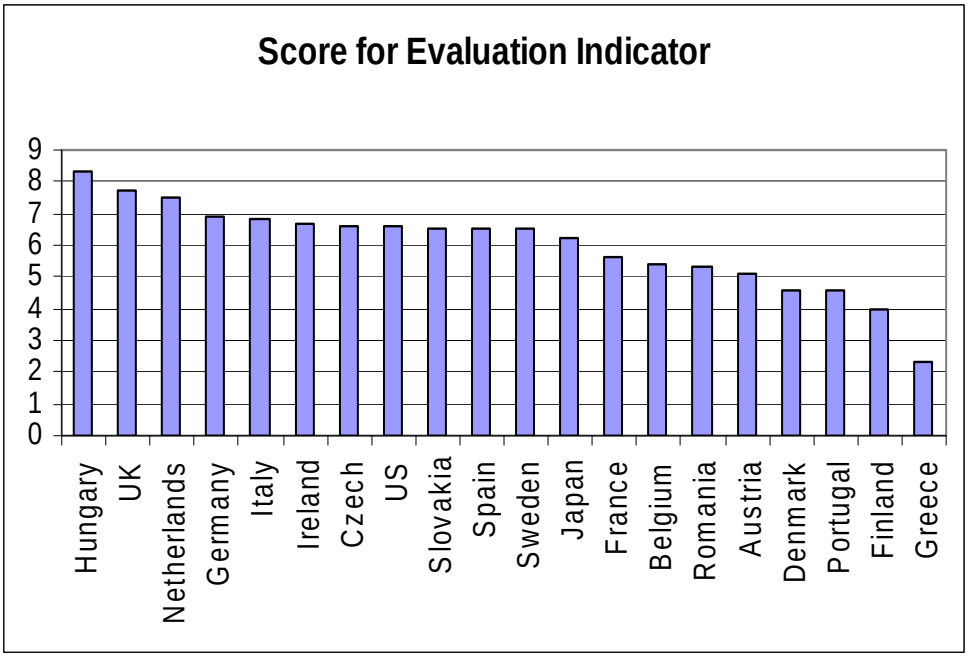


Figure 16 exhibits the scores for the evaluation indicator. Hungary, the UK, and the Netherlands present the highest scores and Portugal, Finland, and Greece present the lowest ones.

Constructed variables

In the estimation of the following sections we will use two composed variables*: wgrad* or weighted graduates, which reflects the number and quality of graduates, and *wpub*, a measure of the number of publications weighted by the number of citations. To be precise we have computed these two variables in the following way:

$$wgrad_t = graduates\ per 1000\ pop_t \times \frac{std.peer\ rev.ind + std.recruiter\ rev.ind}{2} \qquad (4)$$

and $wpub_t = \overline{IndexCit}(t) \times pub_t$, where $\overline{IndexCit}(t)$ is the average of citation indices that included year *t* in their construction.

2. Efficiency Assessment

We applied two different methods in order to measure efficiency in the provision of tertiary education and to identify the relevant non-discretionary (exogenous and environment) variables. Firstly we used a two-stage semi-parametric method, Data Envelopment Analysis (DEA) followed by a regression of output scores on non-discretionary variables; and secondly, a Stochastic Frontier Analysis (SFA) method, including the estimation of a multi-dimensional cost-minimising model with explanatory variables for the inefficiency effect. We turn now into an explanation of these two methods and the ensuing results.

2.1 The semi-parametric analysis method

The two-stage procedure can be briefly described in the following manner.

In the first stage, the researcher identifies relevant inputs (*X*) and outputs (*Y*). Then, the following mathematical programming problem is computed, for a given *i*-th DMU:

$$\begin{aligned} &Max_{\lambda,\delta_i}\ \delta_i \\ &\text{s.to}\quad \delta_i y_i \le Y\lambda \\ &\qquad x_i \ge X\lambda \\ &\qquad n1'\lambda = 1 \\ &\qquad \lambda \ge 0 \end{aligned} \quad . \qquad (5)$$

In problem (5), δ_i is a scalar satisfying $\delta_i \ge 1$. It measures technical efficiency of the *i*-th unit as the distance to the efficiency frontier, the latter being defined as a linear combination of best practice observations. With $\delta_i > 1$, the decision unit is inside the frontier (i.e., it is inefficient), while $\delta_i = 1$ implies that the decision unit is on the frontier (i.e., it is efficient). In what comes next, we will define $\mu_i = \delta_i^{-1}$ as the country *i* DEA output efficient score, which is necessarily greater then zero and no higher than 1. An interesting intuition is that μ_i is the

fraction country *i* is producing of its potential efficiency level. It follows that $\mu_i = 1$ when country *i* is efficient.

This first stage is known as Data Envelopment Analysis, originating from Farrell (1957) seminal work and popularised by Charnes, Cooper, and Rhodes (1978). A full presentation of the method may be found in Coelli *et al.* (2005). Afonso and St. Aubyn (2005) have applied DEA to education and health efficiency across OECD countries.

In the second stage, the following regression is estimated:

$$\mu_i = z_i \beta + \varepsilon_i \,, \tag{6}$$

where μ_i is the efficiency score that resulted from stage one, i.e., from solving (4). z_i contains non-discretionary variables, i.e., exogenous and environment factors.

Typical two-stage applications include the estimation of (6) using censored regression techniques (Tobit).[10] Recently, Simar and Wilson (2007) have criticised the two-stage method, as results are likely to be biased in small samples and propose an alternative estimation and inference procedures based on bootstrap methods. Afonso and St. Aubyn (2006) have applied both the Tobit and the Simar and Wilson bootstrap procedures in the second stage to estimate efficiency in secondary education across countries and contain a relatively detailed explanation of methods. Results from the two methods were very similar. In our study, we have used the Tobit estimation procedure only.

When panel data is available, it becomes possible to apply DEA to more than one period. The researcher will then obtain as many efficiency scores as periods for each country. The mere comparison of those scores is informative as it shows whether a country became closer to or farther away from the efficiency frontier. However, one has to be aware that the frontier itself is usually not static. If that is the case, it becomes important to know if that frontier changed over time, and by how much. In fact, and after applying DEA in two different periods, the Malmquist index allows the decomposition of "total factor productivity change" (*M*) into "efficiency change" (E) and "technical change" (*T*):

[10] See Simar and Wilson (2007) for an extensive list of published examples of the two step approach.

$$M_i = E_i \times T_i . \quad (7)$$

In equation (7), E_i is given by the ratio of efficiency scores for country *i*, and T_i measures the change in the production possibility frontier in country *i*'s vicinity.[11]

2.2 Main results from the semi-parametric analysis

The first stage (data envelopment analysis)

TABLE 4: VARIABLES IN THE TWO-STAGE PROCEDURE

Inputs	**Outputs (in *per capita* terms)**	**Non-discretionary variables**
Model DEA1:	Weighted graduates	Selection of students
Academic Staff	Weighted published articles	Budget autonomy
Students		Staff policy
(in per capita terms)		Output flexibility
Model DEA2:		Evaluation
Spending in PGD institutions		Funding rules
(in percentage of GDP)		PISA results

Table 4 summarises the variables used with this method.[12] We have considered two models, which are referred as model DEA1 and model DEA2. The output part of these models being exactly the same, they differ in what concerns the way inputs are measured.

In model DEA1 we have considered academic staff and students as our inputs. Inputs are therefore measured in physical units, which seems a natural way to measure and compare resources used across units (countries) that differ markedly in what concerns the cost of these resources (prices and wages). Note that it was not possible to collect data for other inputs. One envisaged possibility was to have a third input that would contain other resources used in the tertiary sector, in the manner of Flegg *et al*. (2004) when analysing British universities.[13]

[11] A more complete explanation of the Malmquist index can be found in Coelli *et al*. (2005).
[12] See Appendix A for data on inputs, some non-discretionary variables, and data used to construct the outputs.
[13] These authors included staff, students, and total expenditure other than that on academic and academic-related staff as inputs. See section 1.2 for more examples.

However, this variable was scarcely available and the use of it would drastically reduce the number of countries in our sample.

In model DEA2 we have considered a financial measure of outputs used. Considering nominal spending in PGD institutions has one advantage over using physically measured inputs, as virtually all costs are included. However, it carries also some drawbacks, as differences in costs across countries are controlled in an imperfect way. The widely used PPS correction (i.e., using the same acquisitive power euros across countries) is not enough when it comes to DEA. As wages are a very important part of tertiary education costs, countries where earnings are considerably lower would become artificially more efficient.[14] Measuring financial costs as percentage of GDP seems to be more suitable. It can be assumed as an approximation that any two countries that spend the same proportion of GDP on their tertiary education institutions use a comparable level of resources in this activity.[15]

In both models outputs are considered in *per capita* terms, in order to make it possible to compare countries that are very different in size (both Malta and the US are in the sample).

Our two outputs, weighted graduates and weighted publications, reflect the double nature of tertiary institutions, which is education and research. As explained in section 1, graduates are weighted by quality inferred from the peer review and the recruiter review. Publications are weighted by citations, which is a measure of their impact and usefulness in subsequent research.[16]

It was not possible to compute weighted graduates, academic staff, and students *per capita* for all years and countries, due to missing data. However, and by dividing the whole time span in two sub-periods (1998-2001 and 2002-2005), it was possible to have values for those variables for all countries by averaging existing data.

[14] A DEA model where PPS measured costs were considered as the input is presented in Appendix D.
[15] This approximation is more appropriate for activities where most inputs are nontradable across borders, as is the case of education.
[16] The consideration of these two types of output and weighting for quality is common in the literature on the efficiency of tertiary education institutions. As noted in section 1.2, examples of studies that consider both types of output are McMillan and Datta (1998), Flegg *et al*. (2004), and Stevens (2005), as well as references therein. Worthington (2001) surveys efficiency measurement techniques in education.

Table 5 to 8 summarise results for the two sub-periods. They include the outputs, the inputs, and the efficiency scores. In both cases countries are ranked according to the latter. In Figure 17 we display these rankings for both models.[17] Note that for each model we present two tables, one referring to an input-oriented DEA and the other to an output-oriented DEA. In an input oriented DEA, the efficiency coefficient refers to the horizontal distance to the frontier while in an output-oriented it relates to the vertical distance (see Figure 1). Efficient countries are the same under both orientations and their coefficient equals 1. "Peers" are those efficient countries that dominate inefficient ones. For example, Austria in period 1 is worse than a linear combination of the Netherlands, UK and Japan production conditions, these latter countries being Austria's peers.

TABLE 5: DATA ENVELOPMENT ANALYSIS
MODEL DEA 1 (PHYSICALLY MEASURED INPUTS), INPUT ORIENTED

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coefficient	**Ranking**	**Peers**	**Coefficient**	**Ranking**	**Peers**
Austria	0.777	13	Netherlands, UK, Japan	0.963	9	Netherlands, Denmark, Japan
Belgium	0.846	10	Japan UK	0.973	8	Denmark, UK, Japan
Bulgaria	0.521	21	Japan, Romania	0.517	21	Japan
Cyprus	1.000	1	Cyprus	0.870	10	Japan
Czech Republic	0.624	17	Japan, Romania	0.618	18	Japan
Denmark	0.816	11	Netherlands, UK, Japan	1.000	1	Denmark
Estonia	0.411	27	Japan, UK	0.360	28	UK, Japan
Finland	1.000	1	Finland	0.975	7	UK, Ireland, Sweden
France	0.591	19	Japan, UK	0.644	17	UK, Japan
Germany	0.643	15	Netherlands, UK ,Japan	0.644	16	Netherlands, Japan, Denmark
Greece	0.598	18	Japan Romania	0.511	22	Japan
Hungary	0.488	23	Japan, Romania	0.466	23	Japan, UK
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.808	12	UK ,Japan	0.685	12	UK, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Latvia	0.544	20	Japan, Romania	0.668	13	Japan, UK
Lithuania	0.294	28	Japan, UK	0.402	26	UK, Japan
Malta	0.639	16	Japan, Romania	0.650	15	Japan
Netherlands	1.000	1	Netherlands	1.000	1	Netherlands
Poland	0.493	22	Japan, UK	0.542	20	Japan ,UK
Portugal	0.461	25	Japan, Romania	0.438	25	Japan
Romania	1.000	1	Romania	0.840	11	Japan
Slovakia	0.466	24	Japan, Romania	0.448	24	UK, Japan
Slovenia	0.909	9	Romania, Japan	0.664	14	Japan
Spain	0.441	26	Japan, Romania	0.389	27	Japan, UK
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.655	14	UK, Japan	0.605	19	Japan, UK

[17] In Appendix D we present some results from alternative DEA models.

TABLE 6: DATA ENVELOPMENT ANALYSIS
MODEL DEA 1 (PHYSICALLY MEASURED INPUTS), OUTPUT ORIENTED

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coefficient	**Ranking**	**Peers**	**Coefficient**	**Ranking**	**Peers**
Austria	0.761	11	Netherlands, UK	0.962	9	Denmark, Japan, Netherlands
Belgium	0.839	10	Netherlands, UK	0.972	8	Denmark, Japan, UK
Bulgaria	0.313	26	Ireland, Japan, UK	0.343	25	Ireland, Japan, UK
Cyprus	1.000	1	Cyprus	0.277	28	Japan, Sweden
Czech Republic	0.298	27	Ireland, Japan, UK	0.352	23	Ireland, Japan, UK
Denmark	0.874	9	Netherlands, Sweden, UK	1.000	1	Denmark
Estonia	0.460	17	Ireland, Japan, UK	0.366	22	Ireland, Japan, UK
Finland	1.000	1	Finland	0.996	7	Ireland, Sweden, UK
France	0.566	16	Ireland, Japan, UK	0.599	11	Ireland, Japan, UK
Germany	0.649	12	Japan, Netherlands, Sweden	0.660	10	Japan, Netherlands, Sweden
Greece	0.273	28	Japan, UK	0.294	27	Ireland, Sweden, UK
Hungary	0.323	24	Ireland, Japan	0.333	26	Ireland, Japan, UK
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.627	13	Japan, UK	0.506	14	Japan, UK
Japan	1.000	1	Japan	1.000	1	Japan
Latvia	0.346	23	Ireland, Japan, UK	0.469	17	Japan, UK
Lithuania	0.368	21	Ireland, Japan	0.398	19	Ireland
Malta	0.429	19	Ireland, Japan	0.480	16	Ireland, Japan, UK
Netherlands	1.000	1	Netherlands	1.000	1	Netherlands,
Poland	0.431	18	Ireland, Japan	0.482	15	Ireland, Japan, UK
Portugal	0.365	22	Ireland, Japan, UK	0.376	21	Ireland, Japan, UK
Romania	1.000	1	Romania	0.545	13	Japan, UK
Slovakia	0.316	25	Ireland, Japan	0.346	24	Ireland, Japan
Slovenia	0.593	15	Japan, UK	0.414	18	Japan, UK
Spain	0.382	20	Finland, Ireland, UK	0.382	20	Ireland, Japan, UK
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.598	14	Netherlands, UK	0.550	12	Denmark, UK

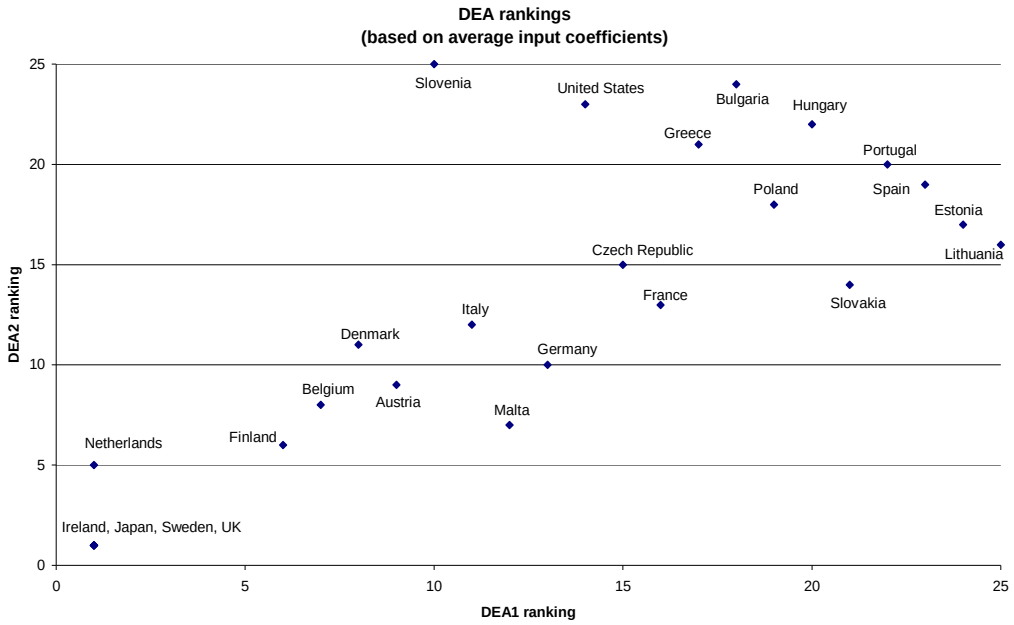
TABLE 7: DATA ENVELOPMENT ANALYSIS
MODEL DEA 2 (FINANCIALLY MEASURED INPUTS), INPUT ORIENTED

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coefficient	**Ranking**	**Peers**	**Coefficient**	**Ranking**	**Peers**
Austria	0.707	10	UK, Japan	0.904	6	Sweden, Japan
Belgium	0.844	8	UK, Japan	0.876	8	Sweden, UK, Japan
Bulgaria	0.426	24	Japan	0.486	20	Japan
Czech Republic	0.605	14	Japan	0.531	17	Japan
Denmark	0.656	11	Netherlands, UK	0.733	10	Sweden, UK, Japan
Estonia	0.519	18	Ireland, Japan	0.551	15	Ireland, Japan
Finland	1.000	1	Finland	0.904	7	Sweden, UK, Ireland
France	0.617	12	Ireland, Japan	0.579	13	Ireland, Japan
Germany	0.724	9	UK, Japan	0.716	11	Sweden, Japan
Greece	0.516	19	Japan	0.423	24	Japan
Hungary	0.467	23	Japan	0.471	22	Ireland, Japan
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.610	13	Japan, UK	0.618	12	Sweden, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	0.529	17	Ireland, Japan	0.542	16	Ireland, Japan
Malta	0.860	7	Japan	0.867	9	Japan
Netherlands	1.000	1	Netherlands	0.994	5	Sweden, UK, Japan
Poland	0.553	16	Ireland, Japan	0.502	19	Ireland, Japan
Portugal	0.490	22	Japan	0.486	21	Japan
Slovakia	0.598	15	Japan	0.564	14	Ireland, Japan
Slovenia	0.371	25	Japan	0.394	25	Japan
Spain	0.490	21	Japan	0.525	18	Ireland, Japan
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.492	20	UK, Japan	0.440	23	Sweden, Japan, UK

TABLE 8: DATA ENVELOPMENT ANALYSIS
MODEL DEA2 (FINANCIALLY MEASURED INPUTS), OUTPUT ORIENTED

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coefficient	**Ranking**	**Peers**	**Coefficient**	**Ranking**	**Peers**
Austria	0.694	9	Sweden, Netherlands	0.886	8	Sweden, Japan
Belgium	0.826	7	Netherlands, UK, Finland	0.858	9	Sweden, UK, Japan
Bulgaria	0.284	23	Ireland, Japan	0.233	25	Ireland, Japan
Czech Republic	0.313	22	Ireland, Japan	0.282	24	UK, Ireland, Japan
Denmark	0.754	8	Finland, Ireland, UK	0.897	7	Ireland, Sweden
Estonia	0.465	17	UK, Ireland, Japan	0.407	16	Japan, UK, Ireland
Finland	1.000	1	Finland	0.995	5	Sweden, Ireland
France	0.579	12	UK, Ireland, Japan	0.451	14	Japan, UK, Ireland
Germany	0.664	10	UK, Japan	0.658	11	Sweden, Japan
Greece	0.280	24	Japan, UK, Ireland	0.289	23	Sweden, UK, Ireland
Hungary	0.330	21	Ireland, Japan	0.306	22	Sweden, UK, Ireland
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.509	13	UK, Japan	0.536	12	Sweden, UK, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	0.467	16	Ireland, Japan	0.398	17	Ireland
Malta	0.597	11	Ireland, Japan	0.698	10	Ireland, Japan
Netherlands	1.000	1	Netherlands	0.993	6	Sweden, UK, Japan
Poland	0.495	15	Ireland, Japan	0.395	18	Ireland
Portugal	0.337	20	UK, Ireland, Japan	0.310	21	Japan, UK, Ireland
Slovakia	0.371	19	Ireland, Japan	0.336	19	Ireland, Japan
Slovenia	0.273	25	Finland, Ireland, UK	0.315	20	Sweden, UK, Ireland
Spain	0.439	18	Japan, UK, Ireland	0.417	15	UK, Ireland, Japan
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.498	14	UK, Finland, Netherlands	0.484	13	Ireland, Sweden

FIGURE 17



The following remarks apply to these first stage results:

- efficiency scores are very similar in both periods. Only a couple of countries changed their position in a striking manner, like Romania and Cyprus in the output oriented DEA1 model. In fact, Cyprus is in technical terms efficient by default in that model - it is not a peer of any other country. This means that although no country is found to be more efficient than Cyprus, it is also the case that Cyprus is not found to be more efficient than any other country. This status is completely altered in period 2. Romania is an almost efficient by default country in period 2. Even if it appears as peer of some other countries, the fact is that withdrawing Romania from the sample does not alter efficiency coefficients for other countries (see Appendix D).
- Ireland, Japan, Sweden, the UK, and the Netherlands were the countries to be found always at the production possibility frontier (or very close to it). In some cases this was essentially due to excellent scientific production (Sweden, Finland, and the Netherlands), whereas Ireland attained its position due to the graduation output, which is not only high in number but also the best in perceived quality (see section 1). The UK is a very good achiever on both counts (education and research) using a comparatively small number of resources (academic staff is below average).
- in contrast, another group of countries appears as highly inefficient. Bulgaria, Spain, Hungary, the Czech Republic, Slovakia, Estonia, Portugal, and Greece display usually low scores. Some of these countries have more tertiary students than average (Spain,

Hungary, Slovakia, Estonia, and Greece). However, these students seem to take a long time to graduate, or an important number of them do not conclude graduation. In all these countries, graduation output is considerably below average. Moreover, and even if academic staff is not too low and sometimes clearly above average (Estonia, Spain), scientific production is low in quantity and quality;

- some of the bigger EU countries (France, Germany, and Italy) are located well below efficiency levels. In the case of Germany, this is due to a small number of graduations compared to the average country. This is also the most important Italian weakness. As far as France is concerned, scientific production is comparatively low, while graduations are above average;
- the US also come out as quite inefficient. Still, we remind the reader that we are considering the public sector only and private institutions are important in this country. The academic staff for this country is below average. However, the number of enrolled students is high and above average, and, on the other hand, graduations are not impressive. Scientific production is slightly above average, but clearly below levels that characterize more productive countries in this matter (the UK and the Nordic countries). Again, one should note that some of the more research-oriented US universities, being private, were not considered in this study.

Changes over time

In Tables 9 and 10, we compare the two considered periods by displaying the Malmquist index decomposition. Observation of the "average" figures (final row of the table) lets us conclude that changes over time in total factor productivity (+12.8 percent in DEA1 and +16.5 percent in DEA2) was substantial and essentially derived from technical change (+22.4 percent) in DEA2 rather than from efficiency changes, while in model DEA1 technical and efficiency changes seem to contribute evenly for total factor productivity. Some countries, like Austria and Denmark, approached efficiency levels in a significant way in both models. Austria reduced the academic staff and the number of students, without worsening the scientific production and only slightly reducing the number of weighted graduates. Denmark exhibits the best comparative performance, as it increased both weighted graduates and weighted publications.

Almost all countries benefited from technical change, as can be inferred from Tables 9 and 10, where the corresponding index is almost always greater than 1. This index corresponds to an expanding production possibility frontier. These expanded possibilities affect countries differently, as we did not impose constant returns to scale.

TABLE 9: DATA ENVELOPMENT ANALYSIS: MALMQUIST DECOMPOSITION
(2005-2002 COMPARED TO 1998-2001)
MODEL DEA1 (PHYSICALLY MEASURED INPUTS)

	Pure efficiency change (1)	scale efficiency change (2)	total efficiency change (3)=(1)×(2)	technology change (4)	total factor productivity change (5)=(4) ×(3)
Romania	0.545	2.837	1.547	1.048	1.621
Latvia	1.355	0.994	1.347	1.072	1.444
Austria	1.264	1.008	1.275	1.081	1.379
Denmark	1.144	1.079	1.235	1.098	1.356
Lithuania	1.084	1.255	1.360	0.984	1.338
Belgium	1.159	1.011	1.172	1.119	1.312
Czech Republic	1.180	0.991	1.169	1.040	1.215
Slovakia	1.094	1.116	1.221	0.995	1.215
Poland	1.120	1.053	1.179	1.007	1.187
France	1.058	1.059	1.120	1.029	1.153
Germany	1.016	1.011	1.027	1.105	1.135
United Kingdom	1.000	1.000	1.000	1.126	1.126
Sweden	1.000	1.017	1.017	1.104	1.123
Malta	1.119	1.010	1.130	0.994	1.122
Bulgaria	1.096	0.995	1.090	1.011	1.102
Greece	1.074	0.904	0.971	1.134	1.102
Italy	0.806	1.191	0.960	1.140	1.094
Hungary	1.031	1.028	1.060	1.029	1.091
Netherlands	1.000	1.000	1.000	1.074	1.074
Japan	1.000	1.000	1.000	1.042	1.042
Finland	0.996	0.946	0.942	1.098	1.035
Portugal	1.032	1.005	1.037	0.998	1.035
Ireland	1.000	1.000	1.000	1.014	1.014
Spain	0.999	0.956	0.955	1.048	1.002
United States	0.920	0.966	0.889	1.119	0.994
Slovenia	0.699	1.207	0.843	1.140	0.961
Cyprus	0.277	2.536	0.701	1.188	0.834
Estonia	0.796	1.051	0.837	0.997	0.834
average	0.961	1.103	1.060	1.064	1.128

TABLE 10: DATA ENVELOPMENT ANALYSIS: MALMQUIST DECOMPOSITION
(2005-2002 COMPARED TO 1998-2001)
MODEL DEA2 (FINANCIALLY MEASURED INPUTS)

	pure efficiency change (1)	scale efficiency change (2)	total efficiency change (3)=(1)×(2)	technology change (4)	total factor productivity change (5)=(4) ×(3)
Austria	1.278	0.976	1.248	1.173	1.464
Ireland	1.000	1.000	1.000	1.412	1.412
Slovenia	1.155	1.088	1.256	1.103	1.385
Sweden	1.000	1.091	1.091	1.171	1.277
Denmark	1.189	0.941	1.118	1.124	1.257
Hungary	0.926	1.003	0.929	1.352	1.256
Slovakia	0.905	0.974	0.881	1.402	1.235
Italy	1.053	1.007	1.060	1.125	1.192
Czech Republic	0.903	1.007	0.910	1.304	1.187
Malta	1.169	0.720	0.842	1.407	1.184
Lithuania	0.853	0.989	0.843	1.402	1.182
Belgium	1.039	1.003	1.042	1.108	1.155
Greece	1.032	0.965	0.996	1.159	1.154
Finland	0.995	1.017	1.012	1.135	1.148
Portugal	0.917	1.003	0.921	1.242	1.143
Bulgaria	0.820	0.988	0.810	1.402	1.135
Netherlands	0.993	0.976	0.969	1.144	1.108
Germany	0.991	0.975	0.966	1.145	1.106
Estonia	0.873	0.992	0.866	1.271	1.101
United Kingdom	1.000	1.000	1.000	1.076	1.076
Spain	0.950	0.991	0.941	1.141	1.074
France	0.780	1.010	0.788	1.309	1.031
Poland	0.798	0.917	0.731	1.402	1.025
Japan	1.000	0.887	0.887	1.118	0.992
United States	0.972	0.911	0.886	1.117	0.990
average	0.977	0.975	0.952	1.224	1.165

The second stage (explaining inefficiency)

Table 4 included all variables that we selected and that could probably have an influence on output scores. They were already described in section 1. They are seven in total.

Six of them refer to institutional characteristics of the tertiary education system (selection of students, budget autonomy, staff policy, output flexibility, evaluation, and funding rules). Recall that these are qualitative variables, such that a high score (close to the maximum of 10) reflects more intensity on that particular characteristic. The minimum score is 0.

PISA is a variable containing the average score of students from a given country in the PISA 2000 exercise. This variable intends to reflect quality and knowledge skills of secondary students. The *a priori* is that more qualified secondary students will enhance efficiency in the tertiary system, as they are less prone to give up studying or to take more years than normal at university.

TABLE 11: TOBIT REGRESSION OF DEA1 COEFFICIENTS ON EXPLANATORY VARIABLES

	two period average input coefficients			**two period average output coefficients**		
	Coefficient	**Standard Error**	***t*-ratio**	**Coefficient**	**Standard Error**	***t*-ratio**
Constant	-1.549	0.7672	-2.019	-2.286	0.7341	-3.114
PISA	0.004089	0.001584	2.582	0.005448	0.001526	3.571
Staff policy	0.03996	0.01815	2.201	0.03364	0.01808	1.861
Adjusted R-squared	0.2731			0.5034		
Number of observations	20			20		
Left censored observations	0			0		
Right censored observations	5			5		
Mean dependent variable	0.7563			0.6822		
Standard error of regression	0.1858			0.1999		

Table 11 includes results from the Tobit regression of DEA1 coefficients on the above-mentioned set of explanatory variables (see equation (4)). Only 20 countries were included in the regression.[18] Non-significant variables were excluded from the final specification. Inspection of Table 11 allows us to conclude that:

- the PISA variable is highly significant, as seen by the very high *t*-statistic. Education quality, as proxied by PISA results, is an important explanatory factor when it comes to explain inefficiency;
- the way staff policy is conducted is also significant. The ability to hire and dismiss academic staff and to set wages increases efficiency.

[18] As mentioned in section 1, we only had explanatory variables data for Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Netherlands, Portugal, Romania, Slovakia, Spain, Sweden, the United Kingdom, and the United States.

TABLE 12: TOBIT REGRESSION OF DEA2 COEFFICIENTS ON EXPLANATORY VARIABLES

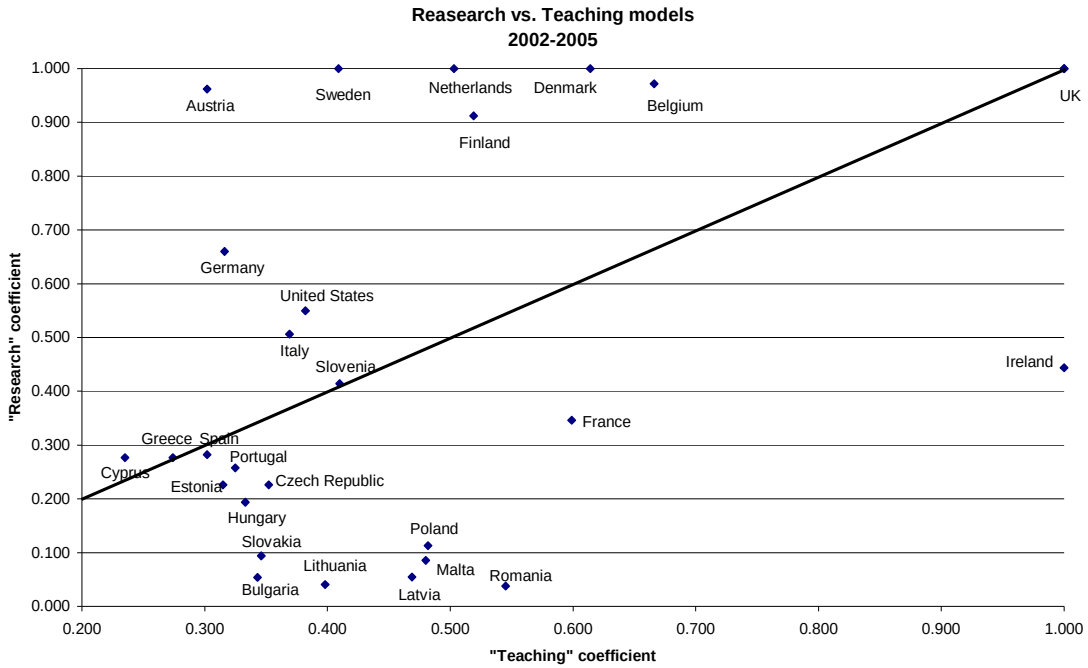
	two period average input coefficients			**two period average output coefficients**		
	Coefficient	**Standard Error**	***t*-ratio**	**Coefficient**	**Standard Error**	***t*-ratio**
Constant	-3.4119	0.5865	-5.817	-4.972	0.6867	-7.240
Funding rules	0.04835	0.02392	2.021	0.0756	0.02796	2.704
Output flexibility	-0.03816	0.01935	-1.972	-0.05803	0.02264	-2.563
PISA	0.007866	0.001266	6.211	0.01069	0.001482	7.213
Staff policy	0.02837	0.01115	2.544	0.03907	0.01304	2.998
Adjusted R-squared	0.7302			0.7964		
Number of observations	19			19		
Left censored observations	0			0		
Right censored observations	4			4		
Mean dependent variable	0.7258			0.6658		
Standard error of regression	0.1115			0.1296		

Table 12 displays results from a Tobit regression of DEA2 coefficients on the significant explanatory variables. Along with PISA and staff policy, funding rules for institutions also affect efficiency. Moreover, output flexibility appears to have a *negative* effect on efficiency, as if greater diversity in supplied courses and degrees were more costly.

2.3 More results from the semi-parametric analysis: the "research" and the "teaching" models

It is well known that in DEA models with more than one output a unit may be efficient when it excels in one dimension even if it is below average in others. We have considered restricted versions of our DEA models where we have only one output, either weighted graduates (the "teaching model") or weighted publications (the "research model"). More detailed results are presented in Appendix D. Here, we refer to Figure 18, where output efficiency scores are compared for both models considering physically measured inputs.

FIGURE 18



The UK is efficient on both accounts, and is represented by a point in the top right corner of the graph. Countries like Slovenia, Spain, or Greece have similar scores in both models. Some countries, however, are clearly located to the right and below the straight thick line. These countries are more efficient if teaching is considered than in what concerns research. Ireland and France are in this group, as all Eastern European countries except Slovenia. On the other hand, the Nordic countries, Austria, and Belgium are clearly more efficient in research than in teaching, as they are above and to the left of the straight line that equalizes scores in both models.

2.4 The stochastic frontier method

The multi-dimensional cost-minimising approach proposed by Battese and Coelli (1995) is also explained by Coelli *et al.* (2005). The reader may refer to Stevens (2005) for an application to universities, as mentioned in section 1.2.

Accounting for multiple outputs within a stochastic frontier analysis usually implies resorting to dual methods, i.e., the direct estimation of a frontier production function is replaced by a cost minimisation problem (see Coelli *et al.*, 2005).

Assume the following stochastic cost frontier:

$$\ln c_{it} = \beta_0 + \beta_1 \ln wpub_{it} + \beta_2 \ln wgrad_{it} + \eta_{it} + \varepsilon_{it}, \quad (8)$$

where *i* indexes a country, and *t* indexes time (years) and:

- c_{it} is the total cost with PGD institutions in country *i*, measured as a percentage of GDP;
- $wgrad_{it}$, one of the considered outputs, are student graduations weighted by quality and *per capita*;
- $wpub_{it}$, the other output, are publications weighted by citations *per capita*.

In equation (8), ε_i is a normally distributed random error, while η_i stands for a non-negative inefficiency effect, assumed to have a truncated normal distribution. Variables are in log form and estimated parameters are therefore elasticities.[19]

As in the two-stage semi-parametric procedure, inefficiency effects are to be explained by nondiscretionary factors represented by z_i:

$$\eta_{it} = \theta_0 + \theta_1 z_1 + ... + \theta_m z_m + \overline{\eta}_{it}, \quad (9)$$

where the *z's* are filled by variables mentioned in Table 13, which sums up variables used with this method. All variables were described in section 1, and already used in section 2, but here we take annual frequencies.

[19] An alternative stochastic frontier model is presented in Appendix E. The dependent variable is the total cost with PDG institutions measured in real purchasing power standards euros per capita. Considering this variable calls for the introduction of wages as an explanatory variable and it was not possible to find a good proxy for wages in tertiary education, as explained in section 1. This alternative approach leads to less convincing results.

TABLE 13: DEPENDENT VARIABLES IN THE COST-MINIMISING MODEL

Input prices	Outputs	Non-Discretionary Variables
Wages in Services	Weighted graduates Weighted Articles	Selection of students Budget autonomy Staff policy Output flexibility Evaluation Funding rules PISA results

Estimation of equation (8) produces estimates for the following parameters of interest:

- the βs, the coefficients associated to the outputs;
- the θs, coefficients associated to nondiscretionary factors that explain inefficiency;
- σ_ε and σ_η, the standard deviations of ε_{it} and η_{it}, respectively.

By computing $\gamma = \frac{\sigma_\eta^2}{\sigma_\eta^2 + \sigma_\varepsilon^2}$ it is possible to produce a likelihood ratio (LR) statistic to test $\gamma = 0$. This LR statistic has a mixed chi-square distribution (see Coelli, 1996). Note that $\gamma = 0$ would imply there were no random inefficiency effects.

Moreover, these estimates make it possible to recover the implied annual efficiency coefficients for each country.

2.5 Results from the stochastic frontier analysis

The model just described was estimated by maximum likelihood using the software Frontier, version 4.1c.[20] The parsimonious selected model, which we call "SFA" is described in Table 14.

[20] This software was written by Tim Coelli and is freely available online from the site http://www.uq.edu.au/economics/cepa/frontier.htm.

TABLE 14: SFA ESTIMATION RESULTS
(DEPENDENT VARIABLE: COST IN PERCENTAGE OF GDP)

	Coefficient	**Standard-Error**	***t*-ratio**
Cost function:			
constant	-1.194	36.37	-0.03283
lwgrad	0.2581	0.04353	5.929
lwpub	0.2707	0.02717	9.961
Inefficiency:			
constant	4.843	36.35	0.1332
staff policy	-0.01002	0.007332	-1.367
evaluation	-0.03954	0.01373	-2.880
funding rules	-0.06146	0.01816	-3.394
PISA2000	-0.007158	0.009246	-7.742
$\hat{\sigma}_{\varepsilon}^{2}$	0.03601	0.004052	8.888
γ	0.09920		
LR statistic (γ=0)	59.67		

We start by noting that the inefficiency component of the model is highly significant. The LR statistic equals 59.67, and clearly exceeds the critical value at 0.1 percent for a mixed chi-square distribution with 6 degrees of freedom (which is 21.666, according to the tabulation of Kodde and Palm, 1986).

The cost elasticities of each output, weighted graduations and weighted publications, are equal to 0.2581 and 0.2707, respectively.

Three institutional variables were found to influence efficiency: staff policy, evaluation, and funding rules. All affect negatively the costs and hence increase efficiency as can be noticed by the negative coefficients. Moreover, results from the secondary education system as given by PISA scores were also important for the efficiency performance at tertiary level.[21]

Table 15 displays efficiency scores implied by the SFA model. These were computed as the ratio between the total cost under efficiency conditions and total observed cost.[22] The

[21] Staff policy is the least significant among all explanatory variables. Withdrawing it led to less reliable estimated efficiency scores. Main results from a variant without staff policy are presented in Appendix E.

[22] It is more common in the SFA literature to compute efficiency scores as the inverse of those displayed in Table 15, i.e., as a ratio between total observed cost and cost under efficiency conditions. These coefficients would be comprised between 1 and infinity. Our transformation ensures some comparability to DEA efficiency scores, as our SFA scores also vary between 0 and 1.

efficiency frontier is achieved when the score equals 1, and a country is less efficient when its score is further from 1 and closer to 0.

TABLE 15: SFA, EFFICIENCY SCORES

	1998	1999	2000	2001	2002	2003	2004	2005	Average	Ranking (average)
United Kingdom	0.730	0.733	0.738	0.737	0.734	0.737	na	na	0.735	1
Japan	0.725	0.720	0.718	0.720	0.721	0.714	0.712	0.720	0.719	2
Netherlands	0.687	0.681	0.683	0.682	0.684	0.683	0.685	0.687	0.684	3
Finland	0.679	0.675	0.678	0.679	0.678	0.678	0.678	0.680	0.678	4
Ireland	0.625	0.624	0.622	0.632	0.637	0.645	0.647	0.650	0.635	5
Austria	0.573	0.568	0.585	0.588	0.586	0.592	0.590	0.588	0.584	6
Sweden	0.576	0.578	0.579	0.580	0.580	0.580	0.583	0.588	0.581	7
Belgium	na	na	0.571	0.569	0.571	0.574	0.578	0.580	0.574	8
France	0.562	0.563	0.565	0.566	0.567	0.559	0.559	0.562	0.563	9
Czech Republic	0.505	0.507	0.509	0.509	0.508	0.507	0.509	0.511	0.508	10
Germany	0.508	0.509	0.509	0.509	0.507	0.504	0.507	0.509	0.508	11
Denmark	na	0.504	0.506	0.502	0.500	0.507	0.508	0.512	0.506	12
United States	0.494	0.493	0.493	0.488	0.486	0.485	0.492	0.492	0.491	13
Spain	0.473	0.475	0.473	0.473	0.473	0.473	0.475	0.477	0.474	14
Hungary	0.466	0.468	0.471	0.474	0.471	0.470	0.480	0.482	0.473	15
Italy	0.463	0.460	0.461	0.459	0.459	0.460	0.470	0.470	0.463	16
Portugal	0.425	0.427	0.429	0.428	0.433	0.430	na	na	0.429	17
Slovakia	na	0.422	0.424	0.421	0.423	0.423	0.418	0.425	0.422	18
Greece	na	na	na	0.326	0.325	na	0.323	0.323	0.324	19

Due to missing data, some scores are not available for some countries and years.[23] Countries are ranked from the more efficient (the UK) to the less efficient (Greece), according to the average scores presented in the last column. In general terms, country positions do not vary much across time. The UK was always the efficiency leader, followed by Japan, the Netherlands, Finland, and Ireland. Greece remained always in the last place. Four of the more populous states in the EU, France, Germany, Italy, and Spain were always far from the efficiency frontier, with scores not revealing an increasing tendency.

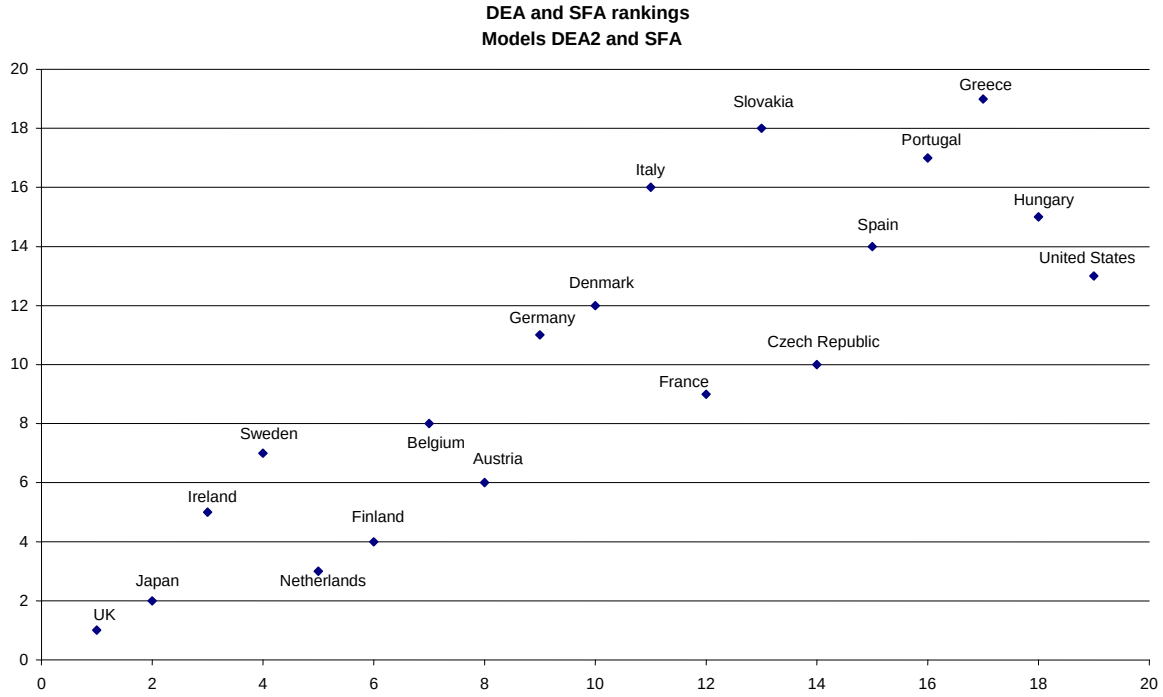
2.6 A summary of efficiency results

We have evaluated efficiency across countries resorting to two different methodologies. It is worth stressing those differences before we engage in a comparison of results:

[23] The estimation method allows for an unbalanced panel of data.

- DEA is a nonparametric method. The *a priori* assumptions about the production possibility frontier shape are kept to a minimum. These are convexity and variable returns to scale. On the other hand, SFA is a regression method and a good number of parameters are estimated. Namely, this implies an *a priori* choice of a functional form for the cost function. In our DEA estimates, we were agnostic till the end about the outputs relative importance. As a consequence, a country that excels in one type of production (e.g., publications) but is less fruitful in the other type (e.g., graduations) may well appear as efficient under DEA. However, it may well fall in SFA rankings, as this method considers both outputs with a relative importance implicit in the regression estimated coefficients;
- We followed a production approach when applying DEA while we resorted to a cost minimisation framework when using SFA. Our DEA models were essentially a relationship between inputs and outputs, either measured in physical or monetary terms. When it came to SFA, we considered cost with tertiary education institutions as the dependent variable in a regression and outputs as explanatory variables. This different formulation, by itself, may induce dissimilar results.
- DEA is a first step of what is properly designated as a two-stage semi-parametric approach. In a second stage, scores previously obtained are regressed on conditioning factors. The SFA approach differs in this respect as it implies only one step. While in the DEA first stage typically more than one country is found at the production possibility frontier, this is rarely the case with SFA.
- The SFA maximum likelihood estimation method allows for an unbalanced panel, while for DEA calculations it is necessary to have a complete panel. We could therefore consider annual data for SFA, while we had to consider averaged data along more than one year with DEA. On the other side of the coin, we could include all countries in the DEA estimations (first step), while a smaller number only could be considered with SFA, due to missing data on environmental and institutional variables.

FIGURE 19



Country rankings derived from DEA2 and SFA are compared in Figure 19. Countries were ordered from the more efficient to the less efficient on both accounts, excluding those for which there were DEA estimates only. We considered the average scores across all years.

Visually, one observes that rankings are correlated – countries that perform with SFA tend to be those well classified with DEA, as is the case with the UK (first on both accounts), Japan, the Netherlands and Ireland. Also, those that perform poorly essentially coincide – Portugal, Greece, or Hungary.

Last but not least, there is one striking and important similarity between the two approaches. Environmental and institutional factors that explain efficiency essentially coincide. These factors are:

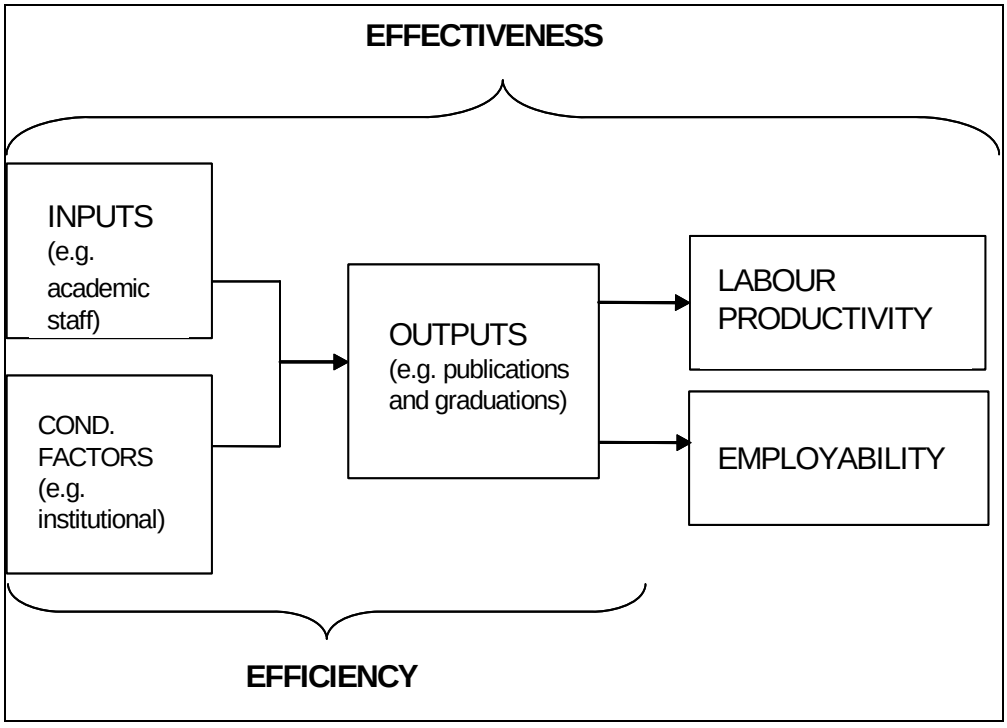
- the quality of secondary education, as proxied by the PISA results;
- the nature of funding rules;
- staff policy and;
- evaluation.

3. Effectiveness Assessment

3.1 The effectiveness assessment approach

At stated previously, effectiveness differs from efficiency as it refers to a relationship between tertiary education and second layer goals or outcomes, for which we consider two possibilities: aggregate labour productivity and graduates' employability. While the latter concerns the matching between higher education outputs and labour market needs, the former is a very close determinant of income *per capita*, a widely used indicator of economic well being. Figure 20 clarifies the relationship between efficiency and effectiveness.

FIGURE 20: EFFICIENCY AND EFFECTIVENESS



When testing the relationship between resources used in education and outcomes (labour productivity and graduates' employability), we will take on board the results of the efficiency assessment carried out in the preceding section. If efficiency is important and if we were successful in measuring it, then it should be the case that what is relevant is not so much the amount of resources spent but also if they are used up in an efficient way. It turns out that empirical results will uphold this approach.

3.2 Effectiveness results concerning labour productivity

The relationship between tertiary education spending and labour productivity was assessed starting from the following growth equation:

$$(lprod05/lprod98)_i = \beta_0 + \beta_1 lprod98_i + \beta_2 inv_i + \beta_3 s_i + u_i\,, \qquad (10)$$

where *i* indexes countries, *lprod98* (*lprod05*) is labour productivity relative to that of the USA in 1998 (2005), *inv* denotes gross fixed capital formation and *s* is public spending on tertiary education. Both *inv* and *s* are defined as a percentage of GDP and averaged over 1998-2005.[24]

In estimating our parameter of interest, β_3, the equation above controls for the effects of capital accumulation and of initial productivity levels, as commonly found in growth regressions. The use of the investment ratio as a proxy for capital accumulation (following Kneller *et al.*, 1999) stems from the unavailability of capital stock estimates for almost half of the countries in our sample. However, since the change in the capital stock is preferable on conceptual grounds, we will include it in an alternative specification (see below).

Variable $lprod_i$ is labour productivity (defined as GDP per person employed) in country *i* divided by labour productivity in the USA. National productivities are measured in purchasing power parity terms[25], so that *lprod* can be used on the right-hand side as an indicator of initial conditions that takes due account of differences in national price levels. The dependent variable, $(lprod05/lprod98)_i$, corresponds to the difference between country *i* and the USA in labour productivity growth from 1998 to 2005.

Equation (10) does not allow for differentiated effects across countries according to their different degrees of efficiency. Therefore, we also estimate the following:[26]

$$(lprod05/lprod98)_i = \beta_0 + \beta_1 lprod98_i + \beta_2 inv_i + \beta_3 eff_i.s_i + u_i\,, \qquad (11)$$

[24] Or over a shorter period, if data availability so imposes.
[25] AMECO variable 1 0 212 0 HVGDE (GDP at current market prices per person employed, 1000 PPS).
[26] Ventelou and Bry (2006) use a similar approach for evaluating the impact of public spending on growth.

where eff_i is the average efficiency score of country *i*. Note that the impact of more spending on public tertiary education is equal to $\beta_3 eff_i$, equivalent to β_3 if country *i* is efficient (eff_i=1) but smaller than β_3 if the country is inefficient (eff_i<1). We estimate equation (11) with the three sets of input efficiency scores described in section 2 of this report, i.e., variable *eff* successively equals DEA1, DEA2 and SFA. These scores were averaged across the 1998-2005 period, which was therefore used in the definition of the remaining variables, as mentioned above[27].

TABLE 16: TERTIARY SPENDING, EFFICIENCY, AND LABOUR PRODUCTIVITY
REGRESSION RESULTS (EU COUNTRIES ONLY)

Equation		(10)	(11), DEA1	(11), DEA2	(10)	(11), SFA
lprod98	coef.	-0.510***	-0.527***	-0.486***	-0.367***	-0.371***
	std. dev.	(0.080)	(0.080)	(0.083)	(0.119)	(0.118)
	P-value	0.000	0.000	0.000	0.002	0.002
inv	coef.	0.819	0.936	1.187*	0.204	0.236
	std. dev.	(0.687)	(0.681)	(0.683)	(0.612)	(0.695)
	P-value	0.233	0.169	0.082	0.739	0.734
s or eff.s	coef.	3.538	4.138	7.053**	1.561	2.719
	std. dev.	(2.829)	(2.533)	(3.321)	(2.450)	(5.552)
	P-value	0.211	0.102	0.034	0.524	0.624
Obs		26	26	23	17	17
R^2		0.735	0.741	0.710	0.583	0.584

The source for variables *lprod98*, *lprod05* and *inv* is the AMECO database, Spring 2008 release. Asterisks *, **, and *** denote significance at 10%, 5% and 1% levels, respectively. Standard errors are heteroscedasticity-consistent (Eicker-White). R^2 is computed as the squared correlation coefficient of actual and fitted values.

In Table 16 we report regression results for equations (10) and (11). Variables *lprod98* and *inv* present the expected signs, though the latter often fails to reach statistical significance. The coefficient of public spending on tertiary education is always positive, but imprecisely estimated, and hence not statistically different from zero, in equation (10).[28] The same holds when adjusting spending for SFA scores (final column of Table 16). However, if one uses DEA scores instead, tertiary spending reaches borderline significance (10,2%) in the case of DEA1, and becomes highly significant (3,4%) in the case of DEA2.

[27] Input coefficients were preferred to output coefficients as they are used to correct spending. Results using an alternative SFA model efficiency scores are given in Appendix F.
[28] This equation was estimated twice, with samples matching those for which DEA or SFA efficiency scores were available.

The USA and Japan were excluded from the regressions in Table 16. In Appendix F we report results including those two countries (Table F2), where the improved significance of DEA-corrected spending can no longer be detected. Though this is a reminder that the results in Table 16 should be regarded with prudence, the exclusion of the two non-European countries can actually be justified on grounds of their much smaller public share in total tertiary education spending (recall section 1). In other words, for the USA and Japan variables *s* and *eff.s* are a rather poor proxy for the amount and efficiency of total resources devoted to tertiary education, and it is total resources (public or private) and the ensuing outputs that should ultimately matter for outcomes such as productivity.

In a simple growth accounting framework, labour productivity growth can be decomposed into the contributions of capital deepening and of total factor productivity (TFP). To bring our modelling approach closer to that framework we proceed in two steps. First, we replace in the previous equations the investment ratio by a more accurate indicator of capital deepening. Second, we study whether public spending on tertiary education – corrected or not by efficiency scores – exerts any beneficial impact on TFP.

We measure capital deepening on the basis of variable kl_i, defined as the net capital stock per person employed in country i[29] divided by the corresponding capital/labour ratio in the USA. As before, the suffix 98 (05) denotes values for 1998 (2005). Hence $(kl05/kl98)_i$ gives the difference between country *i* and the USA in capital deepening (i.e., in the growth of capital per worker) from 1998 to 2005[30]. With this variable, equations (10) and (11) become, respectively:

$$(lprod05/lprod98)_i = \beta_0 + \beta_1 lprod98_i + \beta_2 (kl05/kl98)_i + \beta_3 s_i + u_i \qquad (12)$$

$$(lprod05/lprod98)_i = \beta_0 + \beta_1 lprod98_i + \beta_2 (kl05/kl98)_i + \beta_3 eff_i.s_i + u_i \qquad (13)$$

Table 17 presents the econometric results for equations (12) and (13). Capital deepening strongly contributes to labour productivity growth, whereas initial productivity levels

[29] To derive national capital/labour ratios we divide variable OKND by variable NETD (both from AMECO).
[30] Capital deepening is defined relative to the USA for consistency with labour productivity. Notice, however, that if one used capital deepening in each country "by itself" (i.e., no longer relative to the USA) all results would be unchanged, except for parameter β_2.

completely lose their explanatory power. As for spending on tertiary education, results confirm and even reinforce those of Table 16: expenditure by itself is not statistically significant, but becomes so when corrected for efficiency, regardless of the method used to measure the latter (DEA1, DEA2 or SFA). Nonetheless, one should not lose sight of the fact that we are working with a rather small sample: only 14 EU members (those prior to the 2004 enlargement bar Luxemburg), for which the AMECO database contains figures for capital stocks. Unlike in the case of Table 16, adding the USA and Japan to the sample does not cause efficiency-corrected spending to lose explanatory power (see Appendix F).

TABLE 17: TERTIARY SPENDING, EFFICIENCY, CAPITAL DEEPENING AND LABOUR PRODUCTIVITY
REGRESSION RESULTS (EU COUNTRIES ONLY)

Equation		(12)	(13), DEA1	(13), DEA2	(13), SFA
lprod98	coef.	0.052	0.016	0.033	0.038
	std. dev.	(0.137)	(0.130)	(0.130)	(0.136)
	P-value	0.705	0.903	0.801	0.782
kl05/kl98	coef.	1.170***	1.165***	1.267***	1.255***
	std. dev.	(0.367)	(0.347)	(0.348)	(0.353)
	P-value	0.001	0.001	0.000	0.000
s or eff.s	coef.	4.456	3.998*	5.417***	7.747*
	std. dev.	(2.977)	(2.088)	(2.102)	(4.000)
	P-value	0.134	0.055	0.010	0.053
Obs		14	14	14	14
R^2		0.508	0.526	0.560	0.524

The source for variables *lprod98*, *lprod05* and *kl05/kl98* is the AMECO database, Spring 2008 release. Asterisks *, **, and *** denote significance at 10%, 5% and 1% levels, respectively. Standard errors are heteroscedasticity-consistent (Eicker-White). R^2 is computed as the squared correlation coefficient of actual and fitted values.

We now turn to the possible impact of tertiary education public spending and its efficiency on total factor productivity. In equations (14) and (15), *tfp05* (*tfp98*) is total factor productivity in year 2005 (1998). The remaining variables were already introduced in previous specifications, β_1 being our parameter of interest in both equations.

$$(tfp05 / tfp98)_i = \beta_0 + \beta_1 s_i + u_i \quad (14)$$

$$(tfp05 / tfp98)_i = \beta_0 + \beta_1 eff_i . s_i + u_i \quad (15)$$

Table 18 summarizes results from the econometric estimation of equations (14) and (15). Again, we are dealing with a small sample of 14 EU countries and some prudence applies. The tertiary education public spending coefficient is positive and it becomes statistically significant when corrected by DEA efficiency scores (but not by SFA)[31].

TABLE 18: TERTIARY SPENDING, EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY REGRESSION RESULTS (EU COUNTRIES ONLY)

Equation		(14)	(15), DEA1	(15), DEA2	(15), SFA
s or eff.s	coef.	4.589	4.508**	5.610**	7.069
	std. dev.	2.877	2.210	2.313	4.466
	P-value	0.111	0.041	0.015	0.113
Obs		14	14	14	14
R^2		0.146	0.213	0.251	0.150

The source for variable *tfp05/tfp98* is the AMECO database, Spring 2008 release. Asterisks *, **, and *** denote significance at 10%, 5% and 1% levels, respectively. Standard errors are heteroscedasticity-consistent (Eicker-White). R^2 is computed as the squared correlation coefficient of actual and fitted values.

Overall, the empirical evidence suggests that efficiency matters for effectiveness, results being fairly robust to different methods for efficiency assessment. When weighed by efficiency scores, public spending on tertiary education has a positive and statistically significant impact on labour productivity and on TFP. In a growth accounting framework, the latter can be regarded as one of the contributors to the former.

3.3 Effectiveness results concerning employability

We also investigate whether the efficiency of public tertiary education spending influences the employability of graduates. Taking unemployment rates as the dependent variable, the following equation is estimated:

$$(U2564ter - U2564\text{sec})_i = \beta_0 + \beta_1 gradshare_i + \beta_2 U2564_i + \beta_3 eff_i + u_i, \qquad (16)$$

[31] Adding the USA and Japan to the sample does not cause efficiency-corrected spending to lose explanatory power (see Appendix F).

where *i* indexes countries and *gradshare* is the dimension of the adult (25-64) population having attained tertiary education (ISCED 5-6) relative to (i.e., divided by) adults with secondary education attainment (ISCED 3-4). The unemployment rates *U2564*, *U2564ter* and *U2564sec* refer respectively to the total population aged 25-64 and to those in this age range having attained tertiary or secondary education. As in the case of labour productivity, variable *eff* successively equals DEA1, DEA2 and SFA.

In equation (16) our parameter of interest is β_3, which should take a negative value if it is the case that more efficient spending reduces graduates' unemployment risk relative to those with secondary education only. Variable *gradshare* controls for the relative abundance of graduates (a supply-side effect in the labour market), and *U2564* for other structural characteristics of the labour market. All variables except *eff* are ten-year averages[32] (1998-2007), so as to minimize cyclical effects.

TABLE 19: EFFICIENCY IN TERTIARY SPENDING AND UNEMPLOYMENT RISK OF ADULTS
REGRESSION RESULTS (EU COUNTRIES ONLY)

		DEA1	DEA2	SFA
gradshare	coef.	0.023***	0.025***	0.024***
	std. dev.	(0.007)	(0.008)	(0.007)
	P-value	0.002	0.001	0.001
U2564	coef.	-0.633***	-0.718***	-0.660***
	std. dev.	(0.075)	(0.065)	(0.097)
	P-value	0.000	0.000	0.000
eff	coef.	0.003	-0.016*	-0.043**
	std. dev.	(0.011)	(0.009)	(0.021)
	P-value	0.811	0.068	0.047
Obs		26	23	17
R^2		0.810	0.812	0.759

The source for variables *U2564*, *U2564ter*, *U2564sec* and *gradshare* is Eurostat. In the case of Malta, we have constructed the dependent variable using Eurostat data on employment rates and activity rates in the 25-64 age interval for the respective levels of educational attainment: as is well known, unemployment (*u*), employment (*e*) and activity (*a*) rates can be related by $u = 100*(1-e/a)$. Asterisks *, ** and *** denote significance at 10%, 5% and 1% levels, respectively. Standard errors are heteroscedasticity-consistent (Eicker-White). R^2 is computed as the squared correlation coefficient of actual and fitted values.

[32] Due to missing values, averaging sometimes takes place over a shorter period.

Results in Table 19 show a highly significant effect of variable *gradshare*, with the expected sign: a higher relative supply of graduates increases their relative unemployment rate. The overall unemployment rate (*U2564*) seems to exert the opposite effect, increasing the "employability premium" of tertiary attainment. Finally, in two out of three specifications, more efficient spending is found to minimize the relative unemployment risk of graduates: namely, this is the case for efficiency scores DEA2 and SFA. We have checked that this effect stems from the efficiency of spending, rather than from the financial outlays themselves: public spending on tertiary education – either by itself (variable *s*) or adjusted for efficiency with any of the three sets of scores (variable *eff.s*) – fails to exert any statistically significant influence on the dependent variable.

The samples considered in Table 19 only comprise European countries. As in the analysis of labour productivity, we find that including the USA and Japan causes efficiency scores to lose their statistical significance (full results are reported in Appendix F).

Since our efficiency scores refer to the recent past, one would expect that they have an impact not only on the employability of graduates in general, but also – and perhaps especially – on the employability of young graduates. To check whether such an effect exists, we estimate a modified version of equation (16) where the dependent variable is restricted to the 25-29 age range:

$$(U2529ter - U2529\text{sec})_i = \beta_0 + \beta_1 gradshare_i + \beta_2 U2564_i + \beta_3 eff_i + u_i . \qquad (17)$$

TABLE 20: EFFICIENCY IN TERTIARY SPENDING AND UNEMPLOYMENT RISK OF YOUNG WORKERS
REGRESSION RESULTS (EU COUNTRIES ONLY)

		DEA1	DEA2	SFA
gradshare	coef.	0.015	0.025	0.032
	std. dev.	(0.021)	(0.019)	(0.020)
	P-value	0.487	0.197	0.108
U2564	coef.	-0.733***	-0.838***	-0.955***
	std. dev.	(0.190)	(0.140)	(0.169)
	P-value	0.000	0.000	0.000
eff	coef.	-0.023	-0.077***	-0.240***
	std. dev.	(0.031)	(0.023)	(0.048)
	P-value	0.450	0.001	0.000
Obs		26	23	17
R^2		0.328	0.402	0.466

We have constructed the dependent variable using Eurostat data on employment rates and activity rates in the 25-29 age interval for the respective levels of educational attainment: as is well known, unemployment (*u*), employment (*e*) and activity (*a*) rates can be related by *u = 100*(1-e/a)*. Asterisks *, **, and *** denote significance at 10%, 5% and 1% levels, respectively. Standard errors are heteroscedasticity-consistent (Eicker-White). R^2 is computed as the squared correlation coefficient of actual and fitted values.

The coefficients of variables *gradshare* and *U2564* in Table 20 are broadly similar to their counterparts in Table 19, though the former variable loses statistical significance. More importantly, the impact of efficiency (measured by scores DEA2 or SFA) is substantially reinforced, both numerically and statistically.[33] Therefore, a better efficiency performance of higher education institutions in the 1998-2005 period (used to estimate DEA and SFA scores) seems to benefit particularly those who were studying at that time, or shortly before.

3.4 A summary of effectiveness results

The main message conveyed by the previous analysis is that efficiency matters for effectiveness. Public spending on tertiary education as a percentage of GDP only becomes significantly associated to higher labour productivity growth, or to faster TFP growth, when adjusted for efficiency. As for the other outcome considered – the employability of graduates, proxied by their relative unemployment risk – the empirical support for the importance of efficiency is even stronger, especially in the case of young workers, i.e., those studying roughly in the same period used for the computation of efficiency scores. It is also

[33] No results are presented for a sample including the USA and Japan as we could not find data for *U2529ter* and *U2529sec* for these two countries.

encouraging that, with only a few exceptions, the significance of efficiency is robust to the different estimation methodologies discussed in Section 2 (DEA1, DEA2, SFA).

Conclusions in the previous paragraph, however, do not go without some qualifications. First, the time span considered is rather short (for data availability reasons), preventing us from explicitly taking account of lagged and dynamic effects through panel data modelling. One should note, however, that our analysis of the employability of young graduates goes some way to alleviate this problem, by better aligning the sample years with the likely generation of labour market effects. Second, the cross-section dimension of the sample becomes quite small in some specifications, and results are sometimes sensitive to whether the USA and Japan are included or not (though their exclusion can be plausibly justified on grounds of their much smaller public share in total tertiary education spending). Finally, and as regards the failure to find significant impacts of public spending by itself, one should note that our specification for employability does not easily lend itself to the detection of such an impact: for instance, higher spending probably implies more abundant graduates, and therefore a supply-side increase in their unemployment risk. Therefore, though efficiency matters, it would be rash to conclude that *only* efficiency matters, dismissing the amount of spending as irrelevant.

Conclusions

By estimating efficiency of tertiary public education provision across countries, with proper assessment of variables that explain inefficiency, and also by studying the effectiveness of public spending on higher education, a number of conclusions are warranted. These are:

Inefficiency in spending is an important issue when it comes to public tertiary education. In both our approaches, semi-parametric and stochastic frontier analysis, we could estimate a production possibility or cost frontier, and infer that an important group of countries was found to be operating under inefficiency conditions irrespective of the methods used. These were not only South and Eastern European countries, but also some of the more populous EU member states (France, Germany, and Italy). Also the US public tertiary education sector was found to be very far from efficiency.

Tertiary education systems in a core group of countries in Europe are clearly more efficient. If it is a fact that inefficiency is pervasive across Europe, it is also true that some European countries differ from the rest, in so far as they present clearly better results (outputs) from the consumed resources (inputs). The UK and to a lesser extent the Netherlands appear at the top of the efficiency ranking irrespective of method or models used.[34] On the other hand, some countries tend to be consistently placed at the bottom league (the Czech Republic, Greece, Portugal, and Slovakia).

Tertiary education efficiency is related to institutional factors and also to the quality of secondary education. The quality of secondary education, as measured by results attained by students at PISA internationally comparable tests, is one of the factors that is consistently correlated to country efficiency scores. Other factors pertain to higher education institutional features. These are:[35]

- The funding rules followed in each country. When funding to institutions depends more on outputs (e.g., graduations and publications) and less on historical attributions or inputs, efficiency tends to increase.

[34] This group broadly coincides with those countries mentioned as having a better performance in a recently published Bruegel report (see Aghion *et al*., 2008).
[35] Again, we note a broad correspondence to the factors identified by Aghion *et al*. (2008).

- Evaluation systems. Efficiency tends to be higher in countries where institutions are publicly evaluated by stakeholders and/or independent agencies.
- Staff policy. Institutions' autonomy to hire and dismiss academic staff and to set their wages is correlated with higher efficiency.

Efficient spending matters for labour and total factor productivity. Our analysis of effectiveness showed that there is a positive correlation between tertiary education spending corrected by efficiency scores and labour and total factor productivity. This suggests that the link between resources used in tertiary education and broader outcomes like productivity goes through efficiency. This is evidence in favour of the greater importance of efficiency in higher education spending, as it is not only a matter of public finance but also a way of promoting innovation and growth.

Efficient spending matters for employability. We found that the employability of graduates increases where tertiary education is more efficient. The difference in unemployment rates among graduates and among those with secondary education depends positively on country efficiency scores. This evidence is stronger when young graduates are considered.

Some countries specialise in teaching and others in research. Efficiency analysis showed that some countries seem to specialise more in research than in the teaching part of tertiary education. This is the case of the Nordic countries, of Austria, of Belgium and the Netherlands. Others are more efficient in teaching (Ireland, France, the East European countries). The United Kingdom was found to be efficient on both accounts.

These conclusions lead us to put forward the following broad policy implications.

Spending increases, if they occur, have to be carefully managed and should go hand in hand with institutional reforms. From our analysis it becomes clear that better performing countries are not necessarily those where more resources are spent on higher education. It is efficient spending that matters. It follows that increased spending will be much more successful in output terms if it is efficiency enhancing.

Institutional reform of tertiary educational systems should focus on the following points:

- promoting accountability of tertiary education institutions, with careful and fair evaluation ensured by independent bodies;
- increasing competition, by rising the institutions' autonomy in what concerns staff policy, namely in its ability to hire and dismiss and to set wages;
- designing financial schemes that relate funding to the institutions' performance in output terms, rather than relying in inputs used or in historical trends.

Annex. Case studies.

Netherlands

The Netherlands are one of the top performers in the EU higher education system. The performance in teaching is average in numerical terms, but it is the research dimension that achieves excellence (see Figure 18). Quality in both dimensions is extremely high. Dutch performance compares to that of the Nordic countries, namely Denmark, Finland, and Sweden, but good value for money is one of the main characteristics of the entire Dutch higher education system.

In what follows, we briefly characterize the Dutch higher education system with the purpose of identifying best practices.

Brief characterization of the Tertiary education system in the Netherlands

Analysis of the data

The input figures for tertiary education reveal relatively modest scores. The number of academic staff per 1000 inhabitants was 2.18 in 2005, slightly above average, whereas countries like Sweden (3.66) and Finland (3.42) have higher numbers. The number of students per member of 1000 inhabitants was 34.6 in 2005, again close to the average value of 35.7. Total annual investment in education is just below EU average, even though public expenditure on PGD institutions is quite high (333.7 against an average of 242.1 real Euros PPS per capita).

Regarding outputs, by reviewing an indicator of the 'graduation ratio' (the relationship between the number of graduates and the number of students) the Netherlands are an average performer, since in 2005 about 20% of the students graduate, whereas in the UK the score is 27.7% and in Japan, the incontestable leader, the score is 53.4%. Quality indicators, however, show that the Dutch students are perceived to be among the best. In fact, the Netherlands are placed third in the recruiter review country indicator, just below Ireland and the UK, and fourth in the peer review country indicator, below the Nordic countries.

In research, the score of the Netherlands is excellent. The number of scientific publications per 1000 inhabitants was 0.96 in 2005, quite above the average score of 0.54 for the sample total and only surpassed by the Nordic countries (Sweden, Finland, and Denmark). This fact reveals that the Dutch academic staff is more productive than the average in terms of the number of publications. When one considers the impact of scientific productions, the Netherlands is among the world top. In fact, it attains the maximum value for the average of ISI citation index in the period 1998-2005.

The more general picture is that, in comparison to the other countries under analysis, investment is relatively modest but the output is good and in some cases excellent. The Netherlands thus have an elaborated and well balanced system of institutions that perform well under the given circumstances.

As for the factors that may explain such performance, the Netherlands obtain the highest score for the Staff Policy Indicator and is ranked third in terms of the Evaluation Indicator. The Funding Rules Indicator is slightly above the average value of 5, whereas the Output Flexibility Indicator, which appears to be negatively related to efficiency, is 5.9, well below the average of 6.7.

Structure of institutions and funding arrangements

The higher education system in the Netherlands is nowadays based on a three-cycle degree system, consisting of a bachelor, master, and PhD. Until 2002, the first two cycles at research universities were combined in a single integrated cycle.

There are two types of programmes: research oriented education, traditionally offered by research universities, and professional higher education, traditionally offered by *hogescholen*, or universities of professional education. These programmes differ not only in focus, but also in access requirements, length, and degree nomenclature. Research activities are not traditionally the task of *hogescholen*, but of universities, academic medical centres, and research institutes.

There are thus four categories of publicly funded institutions of tertiary education and research:

- *Hogescholen*: 44 government-funded *hogescholen* in total;
- Universities: 14 universities including the Open University, having a task in education but also in research;
- Academic medical centres: 8 in total, with a triple task: education (bachelor, master, medical specialists, and PhD), research, and patient care; and
- Research institutes: funding organisations for university research, as well as highly specialised top quality research organisations themselves.

As for research, the Dutch research system consists of universities, non-university research institutes, and other research centres (technological institutes). Its heart lies in the universities and academic medical centres.

Institutions of tertiary education in the Netherlands obtain funds from both public and private sources. Many publicly funded institutes also undertake commercial activities and receive tuition fees. The universities speak of three budget streams, two public and one private:

• public formula funding goes directly to institutes of higher education for all their tasks (first stream);
• another stream of public funding goes via the research council to research proposals in competition (second stream);
• private income for commissioned research or other tasks (third stream), business.

Thus, investments in research activities consist of public funds and private funds. The public expenditure for research activities at universities and research institutions amounted to € 3.569 billion in 2003, 0.75% of the GDP but decreasing. This figure is above the average EU-25 figure of 0.64%.[36] Private expenditure on research is more modest. Funding the tertiary system is primarily a governmental task.

[36] Data taken from the OECD Thematic Review of Tertiary Education – The Netherlands (2006).

Explanatory factors for efficiency

Four explanatory variables have proved to be relevant in explaining efficiency, namely, staff policy, output flexibility, evaluation, and funding rules. In what follows, we characterize the Dutch higher education system along each of these dimensions.

1. **Staff Policy**

   1.1. ***Hiring/Firing***

      1.1.1. Autonomy to hire and dismiss academic staff

The Dutch institutions are the decision makers in the field of staff recruitment.

   1.2. ***Wages***

      1.2.1. Autonomy to set wages

Negotiating terms of employment are delegated to the institutions' branch organisations (the association of universities and the association of *hogescholen*). It is thus an internal affair. Furthermore, the institutions of tertiary education and research are autonomous for spending their formula funding received from the government for recruitment of personnel and working conditions.

2. **Output Flexibility**

   2.1. ***Course content and exams***

      2.1.1. Autonomy to set course content

The actual content of curricula and research programmes is up to the institutions themselves, with the remark that the NVAO (the Accreditation Organisation of The Netherlands and Flanders) checks if the profile of a programme is geared to the labour market versus more academically oriented. Furthermore, certain requirements (e.g., those of the accreditation) have to be met in order to receive public funding. And steering at a central level is accomplished by means of financial incentives (as described below in the section on public funding).

2.1.2. Are there academic fields for which the final exam and/or the study programme are the same in all tertiary education institutions throughout the country/jurisdiction?

The law regulates several aspects of the institutions of tertiary education and research. Namely, each programme is obliged to have a specific 'education and exam regulation,' which governs the content of the *curriculum* and the procedures concerning exams. Still, defining study programmes and exams are set by the institutions themselves.

2.2. ***Offer of short studies***

2.2.1. Do tertiary education institutions offer short study programmes (max. duration below 3 years)?

In the period of time under analysis in this report there were no short study programmes offered. Still, short courses with a duration of 2 years, complying with the level descriptor for short higher education in the Bologna framework, became available in *hogescholen* from September 2006 onwards. This change was due to labour market demand and to the fact that the Netherlands seemed to have a lack of diversity within qualifications - with only bachelor, master degrees, and PhD - when compared to other European countries.

2.3. ***Student Choice***

2.3.1. Do tertiary education institutions admit part-time learners, distance-learners, and learners with professional experience (outside the usual enrolment requirements)?

Part-time education is offered, namely at *hogescholen*, as well as dual education, which combines study and work in the same area. Moreover, the Open University, a public funded university, has been providing distance-learning courses in higher education since 1984. The Open University offers full degree courses, but students can also take part of a course or a few subjects only.

Not only secondary education provides a basis for tertiary education. Some learners that have had 'less' formal education, but acquired enough skills and knowledge to enter higher

education through their working experience, are admitted after an entrance examination. The Open University even offers some courses, which have no entrance requirements.

2.4. ***Regional Mobility***

2.4.1. What is the percentage of students enrolled into tertiary education institutions outside their region of high-school graduation?

In what international mobility is concerned, the numbers of foreign students in the Netherlands is well below OECD level and is a fraction of the figures shown by countries such the UK, Belgium, and Germany. The average percentage of foreigners has grown from 2.98% in 1999 to 4.04% in 2003. The number of foreign students in universities is higher (5.6%) than in *hogescholen* (3.17%). Both figures have grown steadily over the reported years.

2.5. ***Existence of* numerus clausus**

2.5.1. Are there academic fields into which entry is restricted or rationed by national/regional regulations?

A *numerus clausus* set by the government (ministers of Education and Health jointly) exists only for students in medicine, dentistry, and some paramedical programmes. However, legislation allows central government to set a maximum enrolment number for certain courses based on labour market considerations. This is the case of the programmes in the arts (music, fine arts). Otherwise, higher education institutions are obliged by law to admit any student with the required secondary school certificate.

3. **Evaluation**

The aim of the Dutch higher education institutions is laid down by law: universities have aims in terms of research and education, *hogescholen* primarily in education. How they do this is their own responsibility. Nevertheless, quality assurance is obligatory.

3.1. ***Institutional evaluation***

There are a number of actors involved with surveillance and control, namely, NVAO (the Accreditation Organisation of The Netherlands and Flanders), the inspectorate of higher education, and the accountancy division of the ministry.

3.1.1. Ministerial oversight

The inspectorate of higher education is an independent part of the ministry. Its task is to check if institutes abide with rules and regulations, and to oversee the functioning of the system.

The accountancy division of the ministry checks whether the expenditure of both ministry and institutions complies with the financial regulations.

3.1.2. Evaluation by an independent agency

3.1.2.1.Teaching

Until 2002, the institutions of tertiary education and research themselves (through their respective branch organisations, the association of universities and the association of *hogescholen*) organised the quality assurance. They had developed a system (originating around 1990) in which self-evaluation was complemented by 'peer review.' Results had to be made public by law. The Minister of Education was still responsible for the quality of (higher) education, and had the right to intervene in the case of serious concern about the quality of a programme or the quality assurance system. But on the whole the institutes themselves were responsible for quality assurance.

In 2002 there was an important change in the quality assurance system for higher education (at both *hogescholen* and universities). The way quality assurance was organised changed into a system of accreditation of programmes, in order to be more internationally comparable.

In this new system, NVAO (the Accreditation Organisation of The Netherlands and Flanders) awards accreditations to programmes, based on a report produced by an independent assessment organisation. Existing programmes have to be accredited every 6 years. New programmes have to be accredited before students can be registered. If a programme is not

accredited, it will lose the right to public funding and the right to award degrees. Accreditation organisations evaluate six main areas: goals, programme (must have relationship with research in the case of universities, or with professional field in the case of *hogescholen*, must be coherent), staff (must be of sufficient quantity and quality), facilities (sufficient material facilities and tutoring), internal quality assurance (systematic evaluation of the programme, in which judgments of staff, students, alumni, and professional field must be incorporated), and results (quality of graduates must meet minimum standards, and output in terms of graduates must meet target figures based on comparable programmes).

3.1.2.2.Research

Quality assurance of research is organised through the 'Standard Evaluation Protocol for public research organisations' and handled by the universities in interaction with the KNAW (Royal Academy of Science) and NWO (Research Council).

This protocol provides both the procedures for assessing the quality of research and the criteria that are used. The main criteria are quality (international recognition and innovative potential), productivity (scientific output), relevance (scientific and socio-economic impact), and vitality/feasibility (flexibility, management, and leadership).

All universities are obliged to evaluate their research activities every three years. Additionally, every six years an external committee – completely independent of the research institutes involved – assesses these research activities. The external assessment covers both the content of the research programme and the management, strategy and mission of the research centre where it is carried out. The results are made public, serving the accountability, and they are also used as a management tool by institutes.

In conclusion, assessment of research quality is still very much performed by the sector itself. Together with the competitive allocation of research council funds, described in section 4.1 below, there is adequate steering on quality of research.

3.2. ***Stakeholder evaluation***

3.2.1. Students' evaluation

On a yearly basis, a large survey among students in tertiary education programmes is conducted in both *hogescholen* and universities. Students assess the quality of their programme on a standardised number of topics. An overview of the results aimed at future students is then compiled giving information on the quality of programmes, which also serves as a benchmark instrument for the institutes themselves.

3.3. ***Labour market***

Even though a number of measures aim at reconciling the number of students in different disciplines supplied by the higher education sector and labour market demand, no formal quality assessment exercise is made by employers. In fact, systematic evaluations for the entire spectrum of courses in tertiary education do not exist in the Dutch system.

3.4. ***Public Information***

3.4.1. Outside observers (e.g., rankings in news magazines, international organisations)

Evidence of the quality of Dutch tertiary education is found in several international university rankings. In rankings such as the Academic Ranking of World Universities 2005 or the Times Higher Education Supplement (2004) the position of Dutch institutions is good. In some areas, they do perform in the first rank in a European context (10 of 13 universities in the European top 100, 12 of 13 appear in World top 500).

3.5. ***Are the results of the quality assessments to be made publicly available?***

Before 2002, peer review results were made public by law. After this date, quality assurance results obtained though institutional evaluation have been used to fill a database providing information on study programmes. Also, the results of the students' assessment are publicly available.

4. **Funding rules**

As mentioned above, there is a system of three streams of money. The first stream is the stream directly financed by the Minister of Education, Science, and Culture. The second stream is the NWO (the Dutch organisation for Scientific Research) and KNAW funding. The first stream is about twice the size of the second stream. The third stream consists of direct commissions for research and education from private companies, central government, the EU, and NGOs.

4.1. ***Public funding***

The first stream of money crucially depends on the registered number of students and number of diplomas (successful completions), the latter having the biggest weight in the funding formula. It is thus mainly output oriented. The formula funding also envisages maintenance of buildings and includes a budget for (fundamental) research that is based on history.

Unlike the funding mechanisms of education, which are largely based on output, the distinctive feature of the second stream of money to finance research is competition on the basis of scientific quality (peer reviews). The amount a university acquires in the second stream depends on the quality of the research proposals. Through the second stream central government is thus able to influence competition and quality aspects of research.

NWO (the abbreviation for the Dutch organisation for Scientific Research) is the organisation that, besides governing several research institutes, allocates research funds to universities. Three allocation procedures are used by NWO:

- Fixed budgets for scientific priorities: NWO identifies promising scientific fields, describing the kind of research to be performed;
- Specific programmes: to stimulate talented young scientists or specific target groups (ethnic minorities, women);
- The ‘open competition:’ for which scientists in all fields can submit research proposals that are evaluated by experts and awarded grants when among the most promising.

4.2. Do the results of quality assessments have an effect on funding decisions?

NVAO (the Accreditation Organisation of The Netherlands and Flanders) determines whether a programme meets the requirements for government funding. All Bachelor and Master Programs at Dutch universities and *hogescholen* need to be accredited in order to (continue to) receive part of the government budget.

4.3. ***Private funding***

4.3.1. Tuition fees and/or households

Funding by students consists primarily of tuition fees. With some exceptions the tuition fee set by the government was € 1496 in the academic year 2005-06.

4.3.2. Business, abroad, other

Contributions by companies are primarily made in terms of research assignments. Like all other continental European countries, the Netherlands does not have a history of companies contributing directly to the higher education institutions by making donations. Through participation in dual courses, giving access to research facilities, commissioning research and other contacts, companies do, however, play a vital role in the system. Still, the contribution made by private businesses to research activities is far below average compared to other OECD countries

5. **PISA**

The Dutch secondary system is performing among the best measured by the international PISA benchmark. Practically all graduates from secondary education progress into further education, mostly into *hogeschool* or university. Access is irrespective of gender or socio-economic background.

United Kingdom

The United Kingdom appears in our analysis as top performer, both when we consider only research outputs and only teaching outputs, as can observed in Figure 18. It is hence important to analyze closely the British tertiary education system to identify the conditions that contribute to this success.

Brief characterization of the Tertiary education system in UK

Analysis of the data

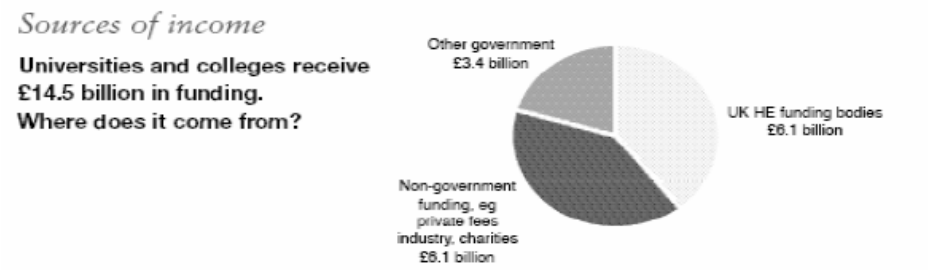
Some analysis of the data may provide insights on why the UK achieves such high levels of efficiency. In what concerns inputs we observed that Academic staff per 1000 inhabitants is low compared to the average of the countries considered in the study (1.55/1.97). On the contrary the number of students per 1000 inhabitants is higher than average, which implies that there is a high ratio of Students per Academic Staff. Although this could be considered as a negative feature for producing graduates, observing the outputs we have precisely the opposite: in the indicator of Graduates per 1000 Inhabitants, UK is placed third and it presents the highest level of Graduates per Academic Staff. So, we have that few academics per student are able to produce a high number of graduates. Moreover, quality indicators also show that graduates of UK institutions are perceived as the second best by recruiters whe compared to the other countries' graduates. This can be explained both through the efficiency of academic staff and by the a priori quality of students as indicated by PISA scores, where the UK are placed second after Japan.

Considering the second output of Tertiary Institutions, research, UK has the sixth highest number of publications per 1000 Inhabitants. Also these publications have a high quality measured by the average number of citations (ISI citation index of 5 on an average of 3.55). Regarding the explanatory factors found relevant for efficiency, we find that the UK has the highest scores for the Staff Policy Indicator and the Evaluation Indicator. As for funding rules, the score is not as high, with UK in the 7th position with a score of 5.5 (the average is 5.0).

Structure of institutions and funding arrangements

In UK, higher education is provided mainly in universities and higher education colleges. All these institutions receive public funds but are independent and self-governing.[37] The expenditure on PGD in the UK as a percentage of GDP is one of the highest among the European countries. In 2005, UK was fourth in this indicator, after Finland, Denmark, and Sweden. However UK universities are not exclusively public funded. The funding is also complemented by non-government funding, which represents around 40% of total funding as can be observed in Figure 21. Part of the non-government funding comes from private tuition fees.

FIGURE 21: SOURCES OF INCOME OF UNIVERSITIES AND COLLEGES IN THE UK (2005)



Source: Higher Education Funding Council for England publication 2005/10.

Also from Figure 21 we observe that around 40% of the total higher education institutions' funding is of the responsibility of higher education Funding Bodies, independent from the government. This has been a tradition of the British system since 1970, and it prevents political influences on the funding of individual universities.

Governance and regulatory framework

Since 1991, the UK has abolished the difference between Polytechnic Institutions and Universities, creating a single sector of teaching and research institutions. The objective was to foster competition between a wider range of institutions such that it would lead to increased efficiency and effectiveness.

[37] There is a very small group of private colleges, government independent, which provide academic programmes for about 0.3-0.5% of all higher education students, mainly in medical-related, business, or theological subjects.

This measure led to the creation of 30 new universities. Criteria were set for higher education colleges to gain their own powers for awarding degrees and for gaining university status.

The specific roles of the Government, Funding Councils, and individual institutions are specified by law.

1) The Government sets the total funding for universities and has the power to set conditions to the Funding Councils covering national developments that it wishes to promote. The Government is not however able to determine the general (or block) grants to individual universities or to intervene in such areas as the content of academic programs, the appointment of staff (including Vice-Chancellors), or the admission of students.
2) The Funding Bodies advise the Government on the needs of higher education and allocate available funds for teaching and research. They also have responsibility for promoting high quality teaching and research, encourage interactions with business and the community, promote widening access and increasing participation, inform students about the quality of higher education available, and ensure the proper use of public funds.
3) Each institution has a governing body who sets the mission and strategic plans and also monitors, supports (and, if necessary, challenge) the performance both of the institution, and of the Vice-Chancellor and senior colleagues. The governing bodies provide the first line of accountability in terms of ensuring that institutions meet the needs of students, local communities, and society (including employers) at large.
4) The National Audit Office (NAO) audits the expenditure of higher education institutions.
5) The Quality Assurance Agency for Higher Education (QAA) ensures the external quality of higher education. It is independent of UK governments and is owned by the organisations that represent the heads of UK universities and colleges. The QAA's role is to judge how well institutions fulfil their responsibility for managing the academic standards and quality of their awards.

As already mentioned, the advantage of the existence of Funding Councils is that decisions about funding for individual universities are not subject to political pressures. The main factor for allocating funds for teaching is the number of students completing a specified element of their program. Funds for research are linked closely with the assessed quality and volume of

research. Hence the allocation of funds will influence significantly the relative emphasis on teaching and research in individual universities. One potential disadvantage of the separate Funding Bodies is the excessive bureaucracy. To limit this effect, the UK Government has an active policy toward reducing imposed bureaucracy on public institutions.[38]

In addition to the funds from Funding Bodies, institutions may apply for research grants from the Research Councils, the European Union and other bodies. They are also encouraged to raise their own funds, for example through the recruitment of overseas students, the development of short professional courses, the setting up of science parks for external companies, the creation of university companies, or donations from alumni.

Explanatory factors for efficiency

1. **Staff policy**

1.1 ***Hiring/Firing***

1.1.1 Autonomy to hire and dismiss academic staff

Universities and colleges determine the criteria for appointing and promoting staff. These depend on the missions of individual universities and colleges. Generally, more emphasis is being placed on teaching quality and contributions to business and the community. Whenever recruitment problems exist, universities may adopt special measures to recruit staff – such as employing staff in employment elsewhere to teach part-time.

1.2 ***Wages***

1.2.1 Autonomy to set wages

As private sector institutions, the universities and colleges have considerable autonomy in what concerns wage definition. They set their own salaries, although the majority chooses to work with other institutions to agree common salary scales for all but the senior staff. Universities are also allowed to reward excellence in teaching and research, according to their own set of rules and objectives.

[38] It has been estimated by the Higher Education Funding Council for England that the cost of bureaucracy for English universities and colleges has been cut by 25% in the four years to 2004 and there is a similar target for the next four years.

2. Output Flexibility

2.1 *Course content and exams*

2.1.1 Autonomy to set course content

Each institution reviews and determines its own set of academic programs and course contents in line with the strategy that it has set itself and its assessment of demand from students. It also determines its emphasis on pure and applied research, having regard to its assessment of the scope for obtaining funds for research.

2.2 *Offer of short studies*

2.2.1 Do tertiary education institutions offer short study programmes (max. duration below 3 years)?

Typical courses last for three years (if taken full-time) and lead to a Bachelors degree with Honours, having a title such as Bachelor of Arts or Bachelor of Science. Also at this level there are short courses and professional 'conversion' courses, based largely on undergraduate material, and taken usually by those who are already graduates in another discipline, leading to Graduate Certificates or Graduate Diplomas.

Foundation degrees are two-year degrees, which aim to give people the intermediate technical and professional skills that are in demand from employers, and to provide more flexible and accessible ways of studying.

There are also short courses at the Masters level often forming part of Continuing Professional Development programmes and leading to Postgraduate Certificates and Postgraduate Diplomas.

2.3 *Student choice*

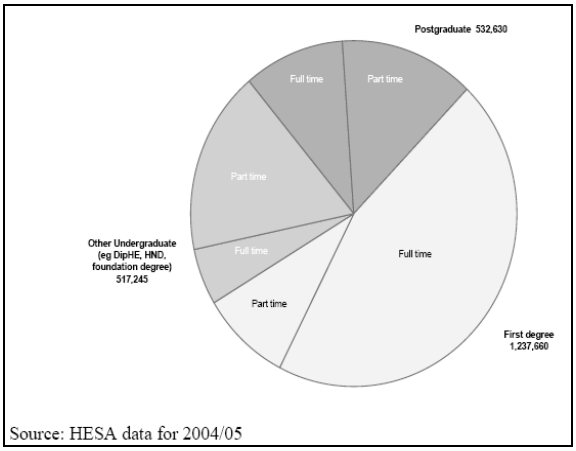
2.3.1 Do tertiary education institutions offer a range of courses within each study programme among which students can choose?

Yes, higher education institutions offer a range of courses and short courses within each study programme.

2.3.2 Do tertiary education institutions admit part-time learners, distance-learners, and learners with professional experience (outside the usual enrolment requirements)?

Part-time studying and distance learning is a reality in UK higher education institutions as there has always been a substantial number of adult students taking degree qualifications part-time. In Figure 22 we observe that roughly one fourth of all students are part-timers. The new Foundation Degrees may be attractive to more adults studying part-time. Individual institutions set their own level of fees for part-time courses. Apart from distance learning, competition is more restricted than for full-time courses because most part-time students study locally. The fees depend more on what students or their employers are willing to pay. Although the numbers of students are close to the numbers of full-time students, the fee income is substantially less because part-time fees reflect the part-time teaching and learning requirements. Many other universities and colleges provide some courses through distance learning, including e-learning.

FIGURE 22: FULL-TIME AND PART-TIME STUDENTS IN UK INSTITUTIONS

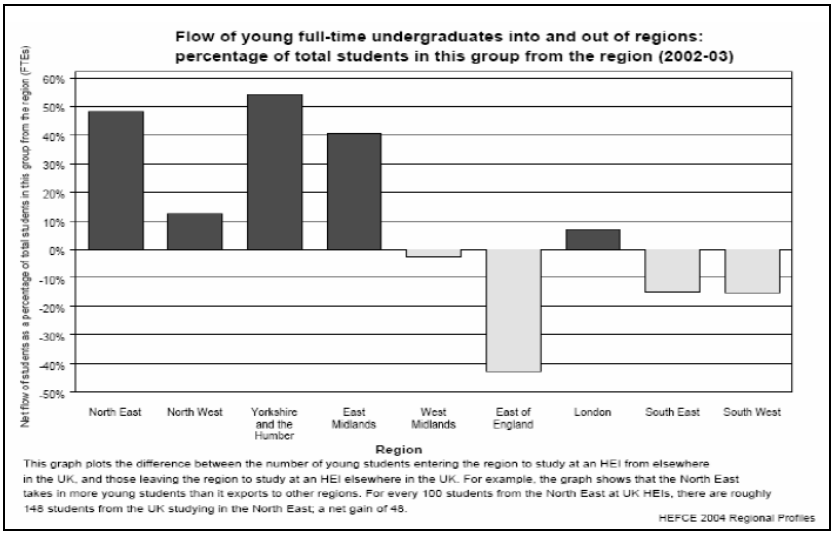


2.4 *Regional mobility*

2.4.1 What is the percentage of students enrolled into tertiary education institutions outside their region of high-school graduation?

Groups of universities and colleges are being formed on a regional basis with the aim of making a maximum contribution to the local and regional economy. However, certain regions are still net importers of students, as for example, Yorkshire, North East, East Midlands, and North West.

FIGURE 23: REGIONAL FLOWS OF STUDENTS IN UK



Source: OECD- Thematic Review of Tertiary Education

2.5 *Existence of* numerus clausus

2.5.1 Are there academic fields into which entry is restricted or rationed by national/regional regulations?

The UK is regarded as having a highly selective system with fixed numbers for every course and different levels of additional selection procedures. However, there are also well-developed alternative routes into higher education, namely through part-time courses.

3. Funding rules

3.1 *Public funding*

There are four stages in calculating the main element of the Higher Education Funding Council for England allocation of teaching funds:

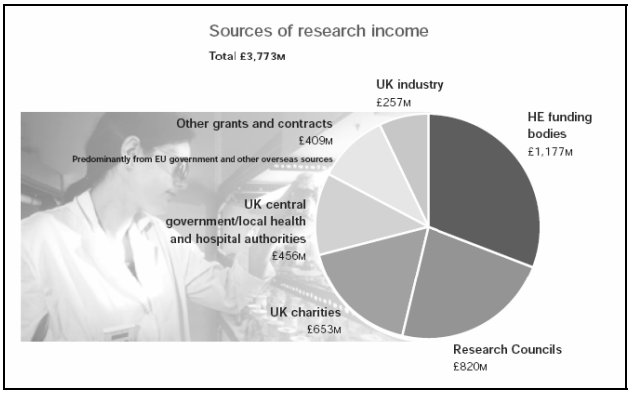
FIGURE 24: STEPS IN THE CALCULATION OF THE FUNDING FOR TEACHING

Stage 1	We calculate a standard resource for the institution. This is a notional calculation of what the institution would get if grant was calculated afresh each year. It is based on each institution's profile of students, and takes into account: • the number of students • subject-related factors • student-related factors • institution-related factors.
Stage 2	We calculate the assumed resource for the institution. This is based on the teaching grant that we actually paid to the institution for the previous year, adjusted for various factors such as inflation, plus our assumptions of student tuition fee income.
Stage 3	We compare the standard resource with the assumed resource and work out the percentage difference between them.
Stage 4	If the difference between the standard resource and the assumed resource is no more than 5 per cent (whether that is plus 5 per cent or minus 5 per cent), then the HEFCE grant will be carried forward from one year to the next. For institutions outside the plus or minus 5 per cent tolerance band, their grant and/or student numbers need to be adjusted so that they move to within the tolerance band.

Source: OECD- Thematic Review of Tertiary Education

Public funding of research in distributed by the Office of Science and Technology to the different Research Councils aiming to support specific research and programmes across the UK, much of it on the basis of competitive bids from researchers in universities and colleges.

FIGURE 25: SOURCES OF RESEARCH INCOME



Source: Higher Education Funding Council for England Guide 2005/10; figures in £ million

The instrument for the allocation of research funds is the Research Assessment Exercise (RAE). The RAE has two purposes. First, it provides comprehensive information on the quality of UK research in every subject area. Secondly, it provides a basis for the allocation of funds in line with the government's policy. The RAE outcome determines the main allocation

(90%) of research funds by the Funding Councils. The precise formula varies between the Funding Councils, although each formula is based on a link between funding and research quality. The allocations for research differentiate significantly according to the assessed quality of research.[39]

3.2 *Outcome oriented*

3.2.1 Funding depend on the number of graduates and/or completed PhDs

The main factor for allocating funds is the number of students graduating from specific courses.

3.2.2 Public funding depend on the number of publications

Funds for research depend on the number of publications and quality of these publications.

3.2.3 Public funding depend on other outputs

Funds for research are linked closely with the assessed quality and volume of research.

3.2.4 Funding depend on outcomes (e.g., final marks, results of evaluations by external commissions or students; quality-adjusted number of publications).

An incentive is the funding available to reward good teaching alongside the negotiated settlements for academic pay. There are initiatives also to raise the status of teaching in higher education – the selective National Teacher Fellowships and associated monetary prizes, the designation of Centres for Excellence in Teaching and Learning (CETLs), and raising the status of the profession of teaching.

3.2.5 Do the results of quality assessments have an effect on funding decisions?

Quality assessments are the main instrument for allocation of funding.

[39] In England, nine universities out of over 130 institutions receive about one half of the total funding allocated on the basis of research quality. At the other end of the spectrum, many universities receive funding in recognition of high quality research in one or two subject areas; and a few may not receive any RAE funding.

3.3 *Private funding*

3.3.1 Tuition fees and/or households

3.3.1.1 Funding from tuition fees

Higher education institutions have always charged tuition fees for part-time undergraduate students and postgraduate students. There have been tuition fees also for full-time home undergraduates for over 50 years. The full-time fees varied between some 10-20% of the average costs of tuition and were paid in full for most students as part of the student maintenance grant. In 1998, the Government decided to set a tuition fee of £1000 for full-time undergraduate students. For the first time, these fees would be paid by students or their parents. Institutions charging higher fees than at present are required to use part of the extra income to support wider access. Subsidised loans will be available to meet the cost and will be repaid after graduation according to a graduate's income.

4. **Evaluation**

The Evaluation of Higher education in UK is very well developed. There exist several mechanisms for this evaluation:

a) The Funding Bodies have established a system of subject review of teaching and learning in both the new and existing universities for each subject. The subject reviews included observation of teaching and were carried out by panels comprising mainly senior academic staff appointed by the Funding Bodies. The functions of subject review and audit were later managed by the Quality Assurance Agency.
b) Research Assessment Exercise (already mentioned) evaluates the Research being done in each institution.

The results of the evaluation are regularly published under Teaching Quality Information (TQI). The purpose of TQI is to make available accurate and up-to-date information about quality and standards to potential students and other stakeholders, such as employers. The TQI consists of quantitative and qualitative data published for each HEFCE funded institution.

The results of the RAE are also publicly available.

Portugal

Portugal appears in our analysis as a poor performer, both when we consider only research outputs and only teaching outputs, as can observed in Figure 18. Other countries have similar performances like Bulgaria, Estonia, Greece, Hungary, and Spain. It is important to analyze closely one of these underperforming countries to identify the conditions that contribute to the inefficient use of resources. We analyze the case of Portugal.

Brief characterization of the Tertiary education system in Portugal

Analysis of the data

Some analysis of the data may provide insights on why Portugal is not able to obtain high levels of efficiency.

In what concerns inputs we observed that Academic staff per 1000 inhabitants is above average (2.0/1.9). On the contrary the number of students per 1000 inhabitants is a lot below average, which implies that there is a low ratio of Students per Academic Staff. Although this could be considered as a positive feature for producing graduates, observing the outputs we have precisely the opposite: Portugal graduates an average of 5.2 individuals per 1000 inhabitants, a low number compared to the average (6.9). Also concerning the indicator of Graduates per Academic Staff Portugal fairs poorly (2.573 as compared to an average of 3.599). So, we have that a high number of academics per student produce a small number of graduates. Moreover, quality indicators also show that graduates of Portuguese institutions are not particularly perceived as high quality by recruiters (standardized recruiter review places Portugal in the middle of the rankings).

These results can be explained by the a priori low quality of students as indicated by PISA scores, where Portugal is placed in the second last position (last position is occupied by Romania).

Considering the second output of Tertiary Institutions, research, Portugal has 0.42 Publications per 1000 inhabitants, a value which is below average (0.541). Although these

figures have improved in time, some work has to be done in what concerns improving the quality of research. Portugal occupies the 17th position in the ISI citation index.

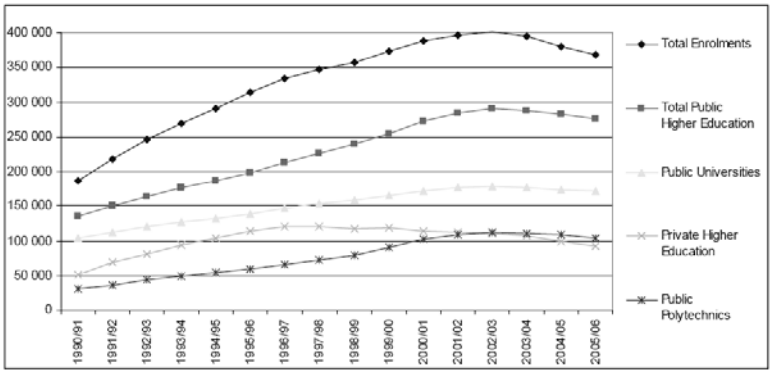
Regarding the explanatory factors found relevant for efficiency, we find that Portugal has the highest scores for the Funding Rules Indicator signifying that funds are allocated effectively. However Portugal appears third from last in the Evaluation Indicator. Regarding the Staff Policy Indicator, Portugal is below average, which is a reflection of the low autonomy that TEI have on hiring/dismissing staff, promoting and establishing incentives and salaries.

Structure of institutions and funding arrangements

Portugal has a binary system integrating universities and polytechnics, both public and private.

Public universities have pedagogical, scientific, and financial autonomy. Although with increasing importance, research in universities is still relatively undervalued in comparison with teaching. Polytechnics are expected to have stronger vocational character than universities and to develop applied research activities, with closer ties to regional and local authorities. Polytechnics are also expected to play a role in regional development.[40]

FIGURE 26 - EVOLUTION OF THE OVERALL NUMBER OF STUDENTS (GRADUATE AND POST-GRADUATE) ENROLLED IN HIGHER EDUCATION IN PORTUGAL, 1990/91 – 2005/06

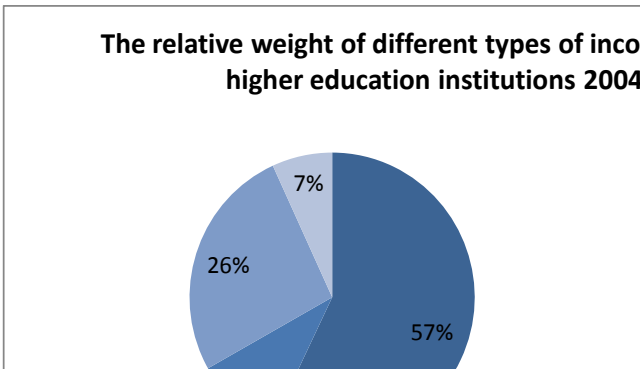


Source: OECD-Thematic Review of Tertiary education Country Background Report: Portugal

[40] This explains why the legislation imposes that local authorities play a role in the polytechnics' governance bodies and that these institutions can set a number of vacancies for students from the respective region.

The expenditure on PGD in Portugal as a percentage of GDP is slightly above average (around 5%). Universities also obtain funds non-public sources, namely fees, earned income and investment, as can be observed in Figure 27.

FIGURE 27: RELATIVE WEIGHT OF DIFFERENT TYPES OF INCOME IN PGD (2004)



Source: OECD-Thematic Review of Tertiary education - Country Background Report: Portugal

Non-government funding constitutes around 40% of total income, 25% of it coming from fees.

Governance and regulatory framework

The purpose of this section is to describe the system of governance and regulation in higher education in Portugal. It also seeks to present significant policy measures that ensure the links between the parts of the system.

1) The government through the Ministry of Science, Technology and Higher Education is responsible for establishing the macro level policies for science, technology and higher education. The Ministry has several policy tools to steer and manage the research and higher education system.
    a. the most important are the control over the distribution of resources (both the current yearly budget as well as the budget for investments in new buildings),
    b. the definition of research priorities,
    c. the power of decision about the creation of new institutions (both public and private),
    d. the control of the number of the academic and non-academic staff of public institutions,

e. the decision on new proposals for study programmes made by public polytechnics and the private sector,
f. the determination and setting of the *numerus clausus* system that allows for the control of the size of the system.
g. negotiating collectively the salaries of academic and non-academic staffs of public institutions, who are civil servants.

2) Public institutions can determine study programmes including curriculum content, staff recruitment and promotion, the internal distribution of resources and have degree granting power. Public universities have additional autonomy as they can decide on the creation of new study programmes.
3) Private institutions have complete discretion over their resources, staff recruitment including work and salary conditions.
4) The Foundation for Science and Technology (FCT), created in 1995, has the mission of mission of promoting the advancement of scientific and technological knowledge in Portugal. It exploits and promotes the opportunities with the potential to meet the highest international standards for the creation of knowledge in different domains. FCT is currently dependent on the Ministry of Science, Technology and Higher Education. FCT's mission is:
    a. promotion of advanced human resources training, through the continued funding of postgraduate awards, mainly for the preparation of doctorates and post-doctoral research;
    b. funding of scientific research and technological development projects in all scientific areas;
    c. support for the development and management of R&D infrastructures;
    d. promotion of the mobility of researchers;
    e. promotion of scientific communication through the funding of a series of activities aimed at promoting communication between scientists and disseminating the national scientific production. This includes support for participation at scientific meetings, production of scientific periodical and non-periodical publications and funding of scientific societies.

FCT's mission is mainly carried out through the award of funding, decided upon after considering the merits of the proposals submitted for its approval, which are usually promoted by scientific institutions, research teams or duly qualified citizens.

System's weaknesses

1) Lack of effective regulation:

   The system grew without adequate regulation, resulting in a network of institutions and study programmes that in most cases do not correspond to the government priorities (to increase the number of graduates in key social and economic areas relevant for the country's development, to increase the diversity of higher education provision, to ensure a balanced geographical provision of higher education and to open the system to students from all socio-economic backgrounds).
2) Contradictions between the increasing autonomy conceded to the institutions and the traditionally centralized and over-bureaucratic system.
3) Little coordination between the different sectors of the higher education system (universities and polytechnics, public and private institutions) and between institutions in the same sector.
4) Historical organizational issues. Previous to 1974, higher education was little developed and access to it was not broad. In the aftermath of the revolution there was an uncontrolled expansion of enrolments and the system became increasingly difficult to manage. A consequence was the hiring of a large number of academics, some of which lacking the qualities for the enhancement of appropriate research and teaching. The organisational problems were exacerbated by lack of tradition in evaluation and accountability, which made it quite difficult to assess reforms and their effectiveness.
5) Deficient system of incentives for academics. Civil servants have their salary levels collectively set and never individually negotiated. Financial incentives or benefits such as bonuses are not available. Reward systems are quiescent and competition reduced to limited promotion opportunities at the higher levels of the career structure. To become a tenured faculty member, it is necessary to be hired in the academic career, to hold a PhD degree (universities) or a master degree (polytechnics), and to have some professional activity (usually 5 years) in teaching and research activities. University staff have an extremely high teaching load (6 to 9 hours a week), as compared to other countries in our study.
6) Low qualification of academic staff. Although increasing, the percentage of academic staff with a PhD is still low by international standards.
7) Poor graduation rates. Graduation rates are a measure of the success of education programmes and of pedagogical efficiency. There are several social, economic,

psychological, and organisational reasons for not completing higher education. A relevant one is the access system to higher education based on *numerus clausus*, which often implies students to enrol in degrees, which are far from their study interests. Another reason concerns low levels of attainment in secondary education.

Explanatory factors for efficiency

1. **Staff Policy**

1.1. ***Hiring/Firing***

1.1.1. Autonomy to hire and dismiss academic staff

There are hiring restrictions in place on the number of permanent staff. Staff increase will usually require the consent of the Ministry of Finances, which may be difficult to obtain in periods of financial stringency. Moreover, the academic, administrative and technical staffs in the different scales (full professor, associated professor, administrator, etc.) are set by law in all public higher education institutions.

In contrast, private institutions have complete autonomy on personnel matters, namely in what the nature and duration of contracts is concerned.

1.2. ***Wages***

1.2.1. Autonomy to set wages

All members of the academic staff in public universities and public polytechnics are civil servants, having their salary levels collectively set and never individually negotiated. Financial incentives or benefits such as bonuses are not available, so that competition is reduced to limited promotion opportunities at the higher levels of the career structure.

In contrast, private institutions can negotiate salary levels.

2. **Output Flexibility**

2.1. ***Course content and exams***

2.1.1. Autonomy to set course content

The autonomy of public universities is sanctioned by the Constitution and the University Autonomy Act (Law 108/88) in principle confers public universities a high degree of autonomy, including pedagogical, scientific, financial autonomy and all the buildings have been transferred to the ownership of the institutions.

The University Autonomy Act (1988) and the Polytechnics Autonomy Act (1990) granted significant levels of autonomy to the public higher education institutions, especially to universities.

Universities have the right to create, suspend, and cancel courses; to design study programmes and subject contents, to define educational methods, select methods of evaluation, and new pedagogical experiments; the freedom in teaching and learning.

Still, new degrees must be registered with the Ministry. Registration can only be rejected if the degrees are considered illegal (for instance because of duration or number of credits).

Public polytechnics are less autonomous, being required to ask for prior Ministry approval to create, suspend, or cancel study programmes

Private institutions of higher education have a high degree of autonomy, but are still obliged to get permission from the Ministry before starting any new degree or changing their study programmes.

2.2. ***Offer of short studies***

2.2.1. Do tertiary education institutions offer short study programmes (max. duration below 3 years)?

Short cycle technological specialisation courses were recently strengthened but they are still not well established.

2.3. ***Student Choice***

2.3.1. Do tertiary education institutions offer a range of courses within each study programme among which students can choose?

In Portugal, the study programmes have been officially organised in credits since 1980, but only recently has this system become compulsory. Moreover, in many cases, assignment of credits to a course tends to be based on a rather rigid way of counting the number of classroom hours of teaching, without consideration for the student's actual workload. Year-by-year syllabus of courses is often established rigidly for each programme, so that students are not allowed to stray away from this fixed curriculum. The number of optional credits is very small and closely related to the programme main theme and in general choice may take place only in the last year of the programme.

2.3.2. Do tertiary education institutions admit part-time learners, distance-learners, and learners with professional experience (outside the usual enrolment requirements)?

Portuguese institutions admit part-time learners and working students, even though the number of students that fall in these categories is quite low. Moreover, the Open University for long-distance learning has long been created. Still, lifelong education is still a relatively underdeveloped area of the Portuguese education system.

Until 2005, students over 25 years of age and without formal qualifications could enter higher education by sitting in special entrance examinations. Since the number of students using this alternative entrance road was very limited – representing only 1% of total first year enrolments in 2004-05 –, in 2006, the government reduced the age criterion to 23 years to encourage candidates to higher education.

Apart from the special entrance examinations, institutions do not admit students from non-traditional access routes, and there is no tradition in the area of recognition of informal training activities.

2.4. ***Regional Mobility***

2.4.1. What is the percentage of students enrolled into tertiary education institutions outside their region of high-school graduation?

Student mobility in Portugal is rather low and the percentage of students living with parents remains high. In a similar way, occupancy of student residences covers only about 4% of the

overall population in higher education and, therefore, is still comparatively lower than in most European countries.[41]

One factor that has contributed to the reduced mobility (after admission in a higher education institution) is the existing limit to the transfer of students between programmes between different higher education institutions, which results from the generalised *numerus clausus* system. In general, every year each institution opens only a limited number of vacancies for transfers between programmes and between institutions and students enter a competition to fill these vacancies.

2.5. ***Existence of* numerus clausus**

2.5.1. Are there academic fields into which entry is restricted or rationed by national/regional regulations?

In Portugal, there exists a generalized system of *numerus clausus* that allows the state to determine the maximum number of enrolments in each scientific or professional area.

3. Evaluation

3.1. ***Institutional evaluation***

3.1.1. Evaluation by a government-funded agency

Quality assessment of research centres and their activity is under the supervision of FCT (the Foundation for Science and Technology). FCT is currently dependent on the Ministry of Science, Technology, and Higher Education and its mission is to promote the advancement of scientific and technological knowledge in Portugal. One of FCT's tasks is to gather independent panels of international experts to assess the quality and productivity of research.

The implementation of this assessment model took place in 1996. The third assessment exercise took place in 2002-2004, focusing on the activities carried out in the period 1999-01, as well as on the activity plans. One hundred and eighty international experts, including some

[41] Data taken from OECD Thematic Review of Tertiary Education – Country Background Report: Portugal, 2006.

Portuguese experts working in foreign institutions, made up the panels responsible for the evaluation.

3.2. *Stakeholder evaluation*

3.2.1. Students' evaluation

Every semester, a large survey among students in tertiary education programmes is conducted in most universities. Students assess the quality of their programme and teaching on a standardised number of topics.

3.3. *Are the results of the quality assessments to be made publicly available?*

The reports produced by the assessment panels organised by FCT and the units' replies are all made public through the Internet. Funding by the FCT continues to be based on the assessment evaluation and the rating attributed to the unit.

4. **Funding rules**

4.1. *Public funding*

Public funding for higher education teaching and research activities consists of two main mechanisms:

- Public funding for higher education institutions:
  - Direct basic funding to public institutions for teaching (through a funding formula);
  - Contractual funding to public institutions (through contracts for specific issues);
  - Direct funding to students (social support of individual grants);
  - Indirect funding to students (includes meals, accommodation, sports and healthcare).
- Public funding for science and technology:

- Direct funding to institutions through R&D units based on periodic evaluation (through pluriannual funding of FCT, defined upon evaluations every 3 years);
- Competitive funding for R&D activities (through projects);
- Competitive funding for people (through individual grants for researchers).

The allocation rationale is currently both input and output-oriented and has been changing to become progressively performance-based. In its 2006 budget, the Government adopted a new formula that progressively introduced criteria related to quality and performance. Since nowadays higher education institutions compete for students, so that the number of students represents some level of performance, the new formula is based on the overall number of students, but includes the following quality factors:

- Qualification of teaching staff, as measured by the fraction of PhDs in the total number of teachers of each institution;

- Graduation rate, as measured based on two indicators:
  - the number of graduates in terms of the first cycle;
  - and the number of master and PhD degrees awarded.

In addition, the formula includes the following two institutional factors to answer to specific characteristics of each individual institution and training area:

- Average personnel cost for each institution, to account for the specific characteristics of the teaching and non-teaching staff of each institution
- Specific student/teacher ratio for each scientific area.

Research funding is mainly a task of FCT, depending on both output quantity and quality and, in some cases, negotiated on a contract basis with achievement of objectives being a requirement for future funding.

4.2. ***Do the results of quality assessments have an effect on funding decisions?***

In the case of research, the level of funding always depends on previous assessments.

4.3. *Private funding*

4.3.1. Tuition fees and/or households

Funding coming directly from the government is by far the largest funding source of Portuguese higher education institutions. Student fees are the third source of funding in importance and have presented a clear growth pattern in nominal terms in recent years, especially due to changes in the funding law in 1997 and 2003. However, they still play a small role for Portuguese public higher education institutions.

4.3.2. Business, abroad, other

The second major source of funding of Portuguese higher education institutions is earned income (without tuition fees). This funding source has acquired a more prominent role in recent years and often contributes with about a quarter of the funds to many institutions, though its importance varies from institution to institution. Some of them, due to their location, prestige and disciplinary composition, are more successful in obtaining funds through this source.

As for research, direct funding from industry exists on a small scale.

5. **PISA**

In 2002 only 13% of the population completed upper secondary education. This low percentage of upper secondary graduation severely limits enrolments in higher education and acts as an obstacle to the adoption of organisational structures in higher education that would allow greater labour flexibility and adaptation, associated with increasingly competitive markets, and scientific development.

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Appendix A – Data

Remark: In the following tables, data for France, Germany, and Spain refer to public institutions of tertiary education.

TABLE A1– ACADEMIC STAFF IN PGD INSTITUTIONS PER 1000 INHABITANTS

		1998	1999	2000	2001	2002	2003	2004	2005
Austria	**AT**	1.80	2.02	na	2.01	2.02	2.08	1.87	1.85
Belgium	**BE**	na	na	1.61	1.75	1.64	1.71	1.72	1.71
Bulgaria	**BG**	na	na	na	na	na	na	1.69	1.75
Cyprus	**CY**	na	1.30	1.22	1.29	1.39	1.58	1.70	1.57
Czech Republic	**CZ**	1.42	1.38	1.39	1.33	1.40	1.40	1.50	1.47
Denmark	**DK**	2.17	na	na	na	na	na	na	na
Estonia	**EE**	2.15	2.34	2.24	2.44	na	2.65	2.64	2.65
Finland	**FI**	2.23	2.87	3.04	3.12	3.25	3.34	3.42	3.42
France	**FR**	2.14	1.67	1.63	1.66	1.70	1.74	1.70	1.76
Germany	**DE**	1.93	1.93	1.94	1.94	1.96	2.02	2.04	1.96
Greece	**EL**	1.31	1.37	1.43	1.70	1.49	1.72	1.86	1.91
Hungary	**HU**	1.70	1.80	1.81	1.91	1.97	2.01	2.06	2.10
Ireland	**IE**	1.95	2.04	2.06	2.34	2.46	2.74	2.89	2.31
Italy	**IT**	1.01	1.16	1.19	1.27	1.27	1.39	1.45	1.48
Japan	**JP**	0.88	0.90	0.91	0.92	0.92	0.91	0.91	0.83
Latvia	**LV**	1.56	1.67	1.52	1.77	1.62	1.36	1.38	1.48
Lithuania	**LT**	2.90	3.16	3.17	na	2.79	2.84	2.77	2.77
Malta	**MT**	na	0.34	na	na	1.57	1.10	1.13	1.67
Netherlands	**NL**	1.59	2.23	2.17	2.21	2.20	2.17	2.18	2.18
Poland	**PL**	1.85	na	1.93	1.96	1.99	2.04	na	2.16
Portugal	**PT**	na	na	1.91	na	na	2.06	2.01	2.02
Romania	**RO**	na	0.78	0.85	0.89	0.98	1.07	1.09	1.10
Slovakia	**SK**	1.86	1.73	1.94	1.92	2.03	2.06	2.04	2.05
Slovenia	**SI**	0.91	0.95	0.96	1.06	1.13	1.11	1.57	1.55
Spain	**ES**	1.91	2.00	2.04	2.19	2.36	2.40	2.43	2.47
Sweden	**SE**	3.05	2.88	3.01	3.10	3.35	3.57	3.70	3.66
United Kingdom	**UK**	na	1.45	1.47	1.50	1.51	1.53	1.57	1.55
United States	**US**	1.74	1.78	1.80	1.79	1.88	1.95	1.86	1.87

Sources: OECD (Online Education Database – UOE database), Eurostat, and AMECO

TABLE A2 – STUDENTS IN PGD INSTITUTIONS PER 1000 INHABITANTS

		1998	1999	2000	2001	2002	2003	2004	2005
Austria	**AT**	31.0	31.6	32.6	32.9	27.7	28.3	29.2	29.7
Belgium	**BE**	na	34.4	34.7	34.9	35.5	36.1	37.1	37.2
Bulgaria	**BG**	28.4	28.9	28.7	27.8	25.5	25.6	25.2	25.8
Cyprus	**CY**	na	7.4	6.6	6.2	7.3	8.1	8.4	8.5
Czech Republic	**CZ**	19.9	21.4	23.3	24.0	25.2	26.3	28.9	29.9
Denmark	**DK**	34.6	35.7	35.4	35.6	36.5	37.4	38.3	38.4
Estonia	**EE**	24.1	26.8	29.6	32.3	34.9	37.4	38.6	39.6
Finland	**FI**	48.5	50.9	52.2	53.9	54.6	55.9	57.4	58.3
France	**FR**	29.4	28.8	28.4	28.1	27.7	28.7	28.9	29.1
Germany	**DE**	24.2	24.0	23.6	23.9	24.8	25.7	26.7	25.2
Greece	**EL**	34.5	35.6	38.7	43.7	48.2	50.9	54.0	58.3
Hungary	**HU**	24.8	27.3	30.1	32.4	34.9	38.5	41.8	43.2
Ireland	**IE**	36.4	37.7	40.1	40.9	42.1	42.7	43.1	41.6
Italy	**IT**	28.6	27.7	29.1	29.6	30.3	31.1	32.0	32.2
Japan	**JP**	6.6	6.7	7.1	7.1	7.2	7.2	7.3	6.4
Latvia	**LV**	26.4	30.7	33.7	37.7	38.4	39.5	40.8	41.0
Lithuania	**LT**	26.4	29.5	33.5	37.5	41.0	46.1	49.6	53.0
Malta	**MT**	na	14.9	16.2	18.9	18.3	22.5	19.6	23.4
Netherlands	**NL**	29.4	29.7	30.6	31.4	32.0	32.5	33.4	34.6
Poland	**PL**	24.8	27.4	29.9	33.3	35.8	37.2	38.3	39.2
Portugal	**PT**	22.7	23.5	24.9	26.6	27.5	27.8	27.5	26.8
Romania	**RO**	11.1	12.4	14.4	17.1	20.0	23.2	24.9	26.7
Slovakia	**SK**	20.9	22.8	25.2	26.8	28.3	29.4	30.6	33.7
Slovenia	**SI**	34.2	39.6	41.7	45.4	49.2	49.6	50.6	53.5
Spain	**ES**	39.2	39.5	39.8	39.1	38.3	37.9	37.2	36.1
Sweden	**SE**	31.7	37.8	39.1	40.2	42.9	46.3	47.8	47.3
United Kingdom	**UK**	33.1	35.5	34.4	35.0	37.8	38.4	37.6	38.0
United States	**US**	35.5	35.0	34.4	35.3	42.4	43.8	43.7	43.7

Sources: OECD (Online Education Database – UOE database), Eurostat, and AMECO

TABLE A3 – EXPENDITURE IN PGD INSTITUTIONS
IN REAL EUROS PPS PER CAPITA

		1998	1999	2000	2001	2002	2003	2004	2005
Austria	**AT**	333.00	343.55	302.23	291.09	277.45	284.49	310.69	336.52
Belgium	**BE**	100.06	277.90	309.15	323.42	326.91	310.05	295.81	302.31
Bulgaria	**BG**	na	55.82	61.84	65.30	68.82	70.78	68.83	71.40
Cyprus	**CY**	na	na	na	na	na	na	na	na
Czech Republic	**CZ**	94.85	101.84	105.93	116.93	125.26	140.97	150.27	154.06
Denmark	**DK**	353.11	369.98	391.59	447.55	475.05	421.15	451.80	433.81
Estonia	**EE**	na	na	na	na	na	na	na	127.70
Finland	**FI**	329.07	365.24	379.78	374.24	383.89	382.58	409.86	401.70
France	**FR**	203.47	210.55	218.03	217.80	219.30	250.23	255.29	260.24
Germany	**DE**	211.34	220.81	221.74	222.33	229.62	246.80	245.72	242.69
Greece	**EL**	156.45	137.00	123.13	168.22	193.77	200.54	239.22	273.17
Hungary	**HU**	93.17	99.54	117.82	125.26	144.12	159.31	135.54	143.31
Ireland	**IE**	276.02	307.81	361.31	327.93	323.18	301.65	319.73	328.32
Italy	**IT**	162.76	181.29	197.72	215.16	210.59	215.24	187.41	196.67
Japan	**JP**	94.48	103.32	109.20	109.59	106.10	116.31	120.88	112.55
Latvia	**LV**	na	na	na	na	na	na	na	na
Lithuania	**LT**	na	61.18	57.65	92.52	98.72	117.07	121.27	129.03
Malta	**MT**	na	73.40	79.88	105.55	108.77	91.07	91.30	77.98
Netherlands	**NL**	257.55	293.11	303.13	320.10	317.30	314.09	325.37	337.93
Poland	**PL**	92.28	80.17	66.72	93.94	114.98	118.62	126.94	145.69
Portugal	**PT**	130.66	141.57	147.96	156.82	145.98	158.63	159.84	178.97
Romania	**RO**	na	na	na	na	na	na	na	na
Slovakia	**SK**	na	73.06	74.30	89.91	90.87	98.13	123.84	111.64
Slovenia	**SI**	na	na	na	na	na	na	220.03	235.64
Spain	**ES**	160.78	170.00	186.94	197.08	205.66	207.64	208.06	208.76
Sweden	**SE**	336.81	361.51	390.30	384.39	403.34	415.18	424.76	409.45
United Kingdom	**UK**	211.85	213.70	220.41	235.55	252.65	250.65	256.74	314.09
United States	**US**	398.14	423.53	446.63	485.43	515.86	535.91	486.61	518.91

Sources: OECD (Online Education Database – UOE database), Eurostat, and AMECO

TABLE A4 – GRADUATES IN PGD INSTITUTIONS PER 1000 INHABITANTS

		1998	1999	2000	2001	2002	2003	2004	2005
Austria	**AT**	3.55	2.24	3.34	3.60	2.61	3.86	4.05	4.27
Belgium	**BE**	na	na	6.77	6.96	7.20	7.31	7.53	7.75
Bulgaria	**BG**	4.56	4.81	5.13	5.34	5.64	5.25	5.07	4.98
Cyprus	**CY**	na	1.77	1.77	1.47	1.63	1.42	1.42	1.56
Czech Republic	**CZ**	2.90	3.30	3.60	4.12	3.98	4.47	5.08	5.07
Denmark	**DK**	na	5.92	6.39	7.47	7.44	8.07	8.79	9.35
Estonia	**EE**	na	na	na	na	na	na	na	6.97
Finland	**FI**	8.37	7.88	7.72	7.31	7.44	7.74	7.90	7.86
France	**FR**	7.20	7.25	7.18	7.18	7.41	8.02	7.95	8.97
Germany	**DE**	4.00	3.91	3.77	3.69	3.65	3.76	3.93	4.10
Greece	**EL**	na	na	na	3.56	3.98	na	4.47	5.51
Hungary	**HU**	4.38	4.81	5.93	5.76	6.23	6.78	6.82	7.42
Ireland	**IE**	9.72	10.27	10.61	11.39	10.88	12.80	12.93	13.48
Italy	**IT**	2.64	2.82	3.19	3.37	3.63	4.11	5.32	6.20
Japan	**JP**	4.00	4.17	4.36	4.26	4.11	3.95	3.90	3.42
Latvia	**LV**	3.92	4.68	5.63	7.44	6.58	6.89	7.62	8.19
Lithuania	**LT**	5.26	6.00	6.93	7.58	8.20	9.48	10.34	11.24
Malta	**MT**	3.47	5.10	5.14	4.75	5.17	5.38	na	6.79
Netherlands	**NL**	5.55	5.06	4.83	5.24	5.47	5.67	6.12	6.71
Poland	**PL**	5.82	5.51	6.62	8.16	8.70	9.07	9.21	9.37
Portugal	**PT**	4.35	4.41	4.48	4.63	4.69	4.75	4.77	5.21
Romania	**RO**	2.09	1.93	2.16	2.44	3.21	4.92	5.35	5.65
Slovakia	**SK**	na	4.03	4.29	4.98	5.37	6.32	6.73	6.93
Slovenia	**SI**	4.03	4.16	4.51	4.61	5.43	5.24	5.94	5.64
Spain	**ES**	5.54	6.04	5.80	6.06	6.24	6.31	6.21	5.89
Sweden	**SE**	4.24	4.72	5.12	5.19	5.50	5.91	6.41	6.69
United Kingdom	**UK**	7.97	8.11	8.56	9.33	9.48	10.10	9.95	10.51
United States	**US**	5.65	5.37	5.73	5.75	5.96	6.32	6.52	6.61

Sources: OECD (Online Education Database – UOE database), Eurostat, and AMECO

TABLE A5 – PUBLICATIONS IN PGD INSTITUTIONS PER 1000 INHABITANTS

		1998	1999	2000	2001	2002	2003	2004	2005
Austria	**AT**	0.69	0.74	0.74	0.79	0.78	0.82	0.84	0.87
Belgium	**BE**	0.71	0.75	0.74	0.78	0.81	0.86	0.90	0.96
Bulgaria	**BG**	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.09
Cyprus	**CY**	0.16	0.16	0.15	0.15	0.19	0.20	0.22	0.24
Czech Republic	**CZ**	0.17	0.19	0.20	0.22	0.25	0.27	0.30	0.30
Denmark	**DK**	0.78	0.79	0.81	0.87	0.90	1.01	1.03	1.00
Estonia	**EE**	0.26	0.33	0.32	0.35	0.34	0.39	0.45	0.50
Finland	**FI**	1.06	1.10	1.15	1.18	1.18	1.24	1.26	1.26
France	**FR**	0.30	0.32	0.32	0.32	0.33	0.33	0.35	0.34
Germany	**DE**	0.52	0.55	0.54	0.55	0.55	0.56	0.57	0.59
Greece	**EL**	0.26	0.26	0.29	0.35	0.41	0.44	0.50	0.54
Hungary	**HU**	0.14	0.15	0.20	0.25	0.26	0.27	0.28	0.31
Ireland	**IE**	0.47	0.47	0.51	0.53	0.60	0.61	0.73	0.78
Italy	**IT**	0.36	0.38	0.39	0.41	0.43	0.46	0.48	0.49
Japan	**JP**	0.35	0.36	0.37	0.37	0.38	0.39	0.40	0.40
Latvia	**LV**	0.08	0.09	0.09	0.10	0.10	0.09	0.10	0.10
Lithuania	**LT**	0.05	0.06	0.07	0.08	0.10	0.12	0.16	0.19
Malta	**MT**	0.09	0.08	0.06	0.07	0.10	0.12	0.08	0.14
Netherlands	**NL**	0.84	0.84	0.85	0.84	0.87	0.87	0.96	0.96
Poland	**PL**	0.11	0.11	0.12	0.15	0.16	0.18	0.21	0.24
Portugal	**PT**	0.19	0.24	0.26	0.28	0.31	0.35	0.40	0.42
Romania	**RO**	0.03	0.04	0.04	0.04	0.05	0.06	0.06	0.06
Slovakia	**SK**	0.18	0.19	0.18	0.18	0.18	0.19	0.22	0.20
Slovenia	**SI**	0.37	0.45	0.53	0.51	0.53	0.60	0.59	0.72
Spain	**ES**	0.35	0.37	0.38	0.40	0.42	0.44	0.46	0.49
Sweden	**SE**	1.09	1.14	1.17	1.26	1.37	1.38	1.42	1.52
United Kingdom	**UK**	0.71	0.73	0.77	0.82	0.83	0.86	0.89	0.92
United States	**US**	0.48	0.48	0.48	0.48	0.48	0.49	0.51	0.53

Sources: ISI Web of Knowledge and AMECO

TABLE A6 – ISI CITATION INDEX

		1998-2002	1999-2003	2000-2004	2001-2005
Austria	**AT**	4.35	4.66	4.77	5.16
Belgium	**BE**	4.27	4.72	4.74	4.98
Bulgaria	**BG**	1.89	2.30	2.49	2.63
Cyprus	**CY**	3.13	2.94	2.50	2.33
Czech Republic	**CZ**	2.33	2.53	2.56	2.90
Denmark	**DK**	4.66	4.36	4.95	5.37
Estonia	**EE**	2.77	2.92	2.96	3.12
Finland	**FI**	4.71	4.90	4.97	5.14
France	**FR**	3.67	3.84	3.92	4.21
Germany	**DE**	4.27	4.49	4.51	4.86
Greece	**EL**	2.20	2.32	2.43	2.71
Hungary	**HU**	2.47	2.78	3.15	3.54
Ireland	**IE**	3.35	3.55	3.61	3.85
Italy	**IT**	3.87	3.99	3.96	4.12
Japan	**JP**	3.66	3.85	3.89	4.10
Latvia	**LV**	1.74	1.86	2.13	2.21
Lithuania	**LT**	1.92	1.94	1.88	1.76
Malta	**MT**	5.76	2.48	2.17	2.45
Netherlands	**NL**	5.17	5.37	5.25	5.51
Poland	**PL**	2.74	2.82	2.82	2.98
Portugal	**PT**	2.69	2.92	2.91	3.07
Romania	**RO**	1.45	1.52	1.58	1.63
Slovakia	**SK**	1.82	2.04	2.02	2.23
Slovenia	**SI**	2.08	2.03	2.11	2.39
Spain	**ES**	3.22	3.33	3.30	3.46
Sweden	**SE**	4.57	4.56	4.68	5.10
United Kingdom	**UK**	4.75	4.79	4.86	5.00
United States	**US**	5.00	5.16	5.19	5.36

Sources: ISI Web of Knowledge

TABLE A7 – STANDARDISED RECRUITER REVIEW AND PEER REVIEW INDEXES

		Recruiter Review Index	Peer Review Index
Austria	**AT**	1.26	1.59
Belgium	**BE**	1.38	1.77
Czech Republic	**CZ**	1.00	1.00
Denmark	**DK**	1.00	1.00
Finland	**FI**	1.03	1.08
France	**FR**	1.30	1.75
Germany	**DE**	1.00	1.00
Greece	**EL**	1.31	2.00
Ireland	**IE**	1.14	1.23
Italy	**IT**	1.20	1.38
Japan	**JP**	1.10	1.07
Netherlands	**NL**	1.00	1.00
Poland	**PL**	2.00	1.94
Portugal	**PT**	1.08	1.15
Romania	**RO**	1.47	1.58
Spain	**ES**	1.00	1.00
Sweden	**SE**	1.00	1.00
United Kingdom	**UK**	1.00	1.00
United States	**US**	1.50	1.82

TABLE A8 – SCORES FOR THE MAIN CATEGORIES OF THE COMPOSITE INDICATOR

		Input Flexibility	Selection of Students	Budget Autonomy	Staff Policy	Output Flexibility	Accountability	Evaluation	Funding Rules
Austria	**AT**	6.80	2.80	7.70	10.00	6.60	5.30	5.10	5.50
Belgium	**BE**	5.20	2.53	6.10	6.97	7.37	5.60	5.43	5.80
Czech Republic	**CZ**	7.90	7.50	6.30	10.00	8.20	5.30	6.60	4.00
Denmark	**DK**	7.70	7.00	6.20	10.00	7.30	5.00	4.60	5.30
Finland	**FI**	7.40	7.10	7.70	7.50	8.40	5.10	4.00	6.20
France	**FR**	3.80	2.80	6.80	1.80	6.40	6.10	5.60	6.60
Germany	**DE**	5.80	2.80	7.20	7.50	3.00	6.10	6.90	5.20
Greece	**EL**	1.90	1.70	0.90	3.20	3.60	3.50	2.30	4.60
Hungary	**HU**	6.80	8.90	8.50	3.20	7.30	6.30	8.30	4.30
Ireland	**IE**	7.80	5.50	10.00	7.90	6.60	6.30	6.70	5.90
Italy	**IT**	6.20	3.70	7.00	7.90	6.40	6.00	6.80	5.20
Japan	**JP**	8.20	6.60	8.20	10.00	9.10	5.10	6.20	3.90
Netherlands	**NL**	6.30	1.30	7.70	10.00	5.90	6.30	7.50	5.10
Portugal	**PT**	6.20	3.90	7.20	7.40	7.30	6.20	4.60	7.80
Romania	**RO**	6.90	6.60	5.80	8.30	5.00	4.20	5.30	3.10
Slovakia	**SK**	8.40	6.70	8.50	10.00	8.20	4.70	6.50	2.90
Spain	**ES**	7.60	10.00	7.90	4.90	5.70	5.70	6.50	4.80
Sweden	**SE**	8.40	8.90	6.20	10.00	5.50	5.60	6.50	4.60
United Kingdom	**UK**	7.80	6.70	6.80	10.00	8.20	6.60	7.70	5.50
United States	**US**	8.20	6.10	8.50	10.00	7.00	5.10	6.60	3.60

Source: Oliveira Martins *et al*. (2007)

TABLE A9 – PISA 2000

		PISA 2000
Austria	**AT**	514
Belgium	**BE**	508
Czech Republic	**CZ**	500
Denmark	**DK**	497
Finland	**FI**	540
France	**FR**	507
Germany	**DE**	487
Greece	**EL**	460
Hungary	**HU**	488
Ireland	**IE**	514
Italy	**IT**	473
Japan	**JP**	543
Netherlands	**NL**	525 a)
Portugal	**PT**	456
Romania	**RO**	410 a)
Slovakia	**SK**	482 a)
Spain	**ES**	487
Sweden	**SE**	513
United Kingdom	**UK**	528,00
United States	**US**	499,00

a) drawn from PISA 2006
Source: PISA publications 2000.

Appendix B - Data sources and remarks

Academic Staff

Main Sources: OECD (Online Education Database – UOE database, Dataset: Educational Personnel) and Eurostat (Dataset: Teachers (ISCED 0-4) and academic staff (ISCED 5-6) by employment status (full-time, part-time, full-time equivalence) and sex).

Remarks: Most data was taken from the OECD dataset, which classifies academic personnel into public, government-dependent private, and independent private institutions, with the exceptions that follow. For some years and countries for which no data was available from OECD - namely Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Portugal in 2003 and 2005, Romania, Slovakia, and Slovenia - some numbers were recovered from Eurostat, where only data for academic staff in all institutions is available, according to the methodology that follows. In the case of Bulgaria, Estonia, Latvia, Lithuania, Portugal, Romania, and Slovenia, countries where private independent universities are relevant, we computed the proportion of academic staff in PGD universities using the weight of the public sector as follows:

$$Academic\ staff\ \ in\ all\ universities\,(Eurostat)\times\frac{students\ in\ PGD\ institutions}{all\ \ students}.$$

Students in PGD Private Institutions:

Source: OECD (Online Education Database – UOE database, Dataset: Students enrolled by type of institution) and Eurostat (Dataset: Students by ISCED level, type of institution (private or public) and study intensity (full-time, part-time))

Remarks: Most data was extracted from OECD, except for the following. Data for Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Romania, Slovakia, and Slovenia was drawn form Eurostat.

Expenditure/financial data

Total Expenditure on PGD Institutions in Percentage of GDP:

Source: Eurostat (Dataset: Expenditure on public educational institutions).

Total Expenditure on PGD Institutions in Purchasing Power Standard in Real Terms *Per Capita.*

Source: This data has been constructed using the dataset *Expenditure by nature and resource category* from the UOE data collection, as well as data on population, ECU-EUR average exchange rates, GDP purchasing power parities, and the euro area price deflator of the gross domestic product at market prices of the year 2000 obtained from AMECO Database.

Total Public Expenditure on Tertiary Education

Source: OECD (Online Education Database – UOE database).

Total Public Expenditure for Educational Institutions (Tertiary Education)

Source: OECD (Online Education Database – UOE database).

Remarks: Though less comprehensive than the preceding variable, it presents the advantage of comparability with private direct expenditures for educational institutions.

Output data

Graduates in PGD Institutions:

Source: OECD (Online Education Database – UOE database, Dataset: Graduates by field of education and Graduates by age), Eurostat (Dataset: Graduates by ISCED level, type of institution (private or public), age and gender), and UIS (UNESCO Institute for Statistics,

Dataset: Graduates by broad field of education in tertiary education). Data for France and Germany only includes public institutions.

Remarks: Most data was taken from the OECD dataset, which divides graduates into ISCED 5B and ISCED 5A and 6, and finally ISCED 6 in public and private institutions. Data for graduates in PGD institutions is scarce.
To overcome the problem of lacking of data, we have constructed a proxy of the number of graduates in PGD institutions using the data of Students in ISCED 5 and 6 in PGD institutions and Students ISCED 5 and 6 in all institutions. Namely, we computed the proportion of students in PGD institutions over the students in all institutions and used this proportion to obtain an estimate of the graduates in PGD institutions. The same methodology was used to recover graduates in ISCED 5 and ISCED 6 separately in PGD institutions.
For those years and countries for which no data was available from OECD, numbers were recovered from Eurostat (namely for Greece from 2001 to 2002, Portugal from 1998 to 2002, Slovenia from 1998 to 2005, and the US for 2002) and from the UIS (namely for Bulgaria, Estonia, Latvia, Lithuania, and Romania).

THES - QS recruiter survey ranking:

Source: THES (Times Higher Education Supplement) - QS (Quacquarelli Symonds) World University Rankings. Data available online: www.topuniversities.com.

Remarks: The recruiter review is only one of the indicators used by THES - QS to rank universities. Other indicators concern the peer review (see below), international staff, international students, the staff/student ratio, and citations of academic work.

THES - QS peer survey ranking:

Source: THES (Times Higher Education Supplement) - QS (Quacquarelli Symonds) World University Rankings. Data available online: www.topuniversities.com.

Remarks: The peer review is only one of the indicators used by THES - QS to rank universities. Other indicators concern the employer review (see above), international staff, international students, the staff/student ratio, and citations of academic work.

Published articles:

Source: ISI Web of Knowledge, Thomson Scientific, The Thomson Corporation. Data available online to ISI subscribers (www.isiwebofknowledge.com).

Remarks: The ISI Web of Science Database includes the Science Citation Index expanded (available data from 1900), the Social Sciences Citation Index (available data from 1956) and the Arts & Humanities Citation Index (available data from 1975). Data were collected from 1998 onwards.

Citations:

Source: ISI Web of Knowledge, Thomson Scientific, The Thomson Corporation. Data available online to ISI subscribers (www.isiwebofknowledge.com):

Remarks: The ISI Web of Science Database includes the Science Citation Index expanded (available data from 1900), the Social Sciences Citation Index (available data from 1956), and the Arts & Humanities Citation Index (available data from 1975). Data were collected from 1998 onwards.

Institutional and environment data

Supply of tertiary education (STE)

Source: Oliveira Martins *et al.* (2007)

Remarks: The indicator has been constructed on the basis of a questionnaire sent to OECD member countries, 28 of which have provided answers. We extended coverage to the remaining countries considered in our study (see Table 1) and had positive replies from Cyprus and Romania. For this purpose, we have sought and obtained permission from the OECD Economics Department to use their questionnaire.[42]

[42] We are grateful to Joaquim Oliveira Martins for his help in obtaining this permission.

PISA

Source: PISA publications - Programme for International Student Assessment (PISA).

Macroeconomic data

Our main source for macroeconomic variables including population is the AMECO database, Spring 2008 release. Data for activity rates, employment rates, and unemployment rates were drawn from Eurostat.

Appendix C - The OECD questionnaire

ISEG/LISBON TECHNICAL UNIVERSITY

Study on the efficiency and effectiveness of public spending on tertiary education

QUESTIONNAIRE ON THE INSTITUTIONAL SET-UP OF TERTIARY EDUCATION

Background

An ISEG/Technical University of Lisbon team is currently undertaking a study on the efficiency and effectiveness of public spending on tertiary education in the EU for the European Comission, Directorate General Economic and Financial Affairs, under contract number ECFIN/329/2007/486218.

Efficiency and effectiveness may be affected by the institutional factors characterising the supply of tertiary education. Therefore, it is important to collect institutional and statistical information on the supply of tertiary education not yet available. Your answers would allow constructing tertiary education policy indicators that are likely to capture the quality and the quantity of tertiary education supply, such as indicators of autonomy, accountability, diversity, and funding rules. As the analysis will rely on econometric techniques, these supply-side indicators have to be, as far as possible, comparable across member countries.

This questionnaire is equal to the one sent by the OECD Economics department in 2006 to OECD member countries. We are sending is now to EU countries not belonging to the OECD in order to have a complete data set. We are grateful to the OECD for letting us use a questionnaire that was completely designed by this organisation[1].

Please respond by the end of **June 2008**.

The design of the questionnaire

Many questions are based on a multiple choice, yes/no, or single data formats. No detailed description of policies is requested. Nevertheless, short descriptions of the salient features of the tertiary education system would be helpful in assessing responses and respondents are encouraged to supplement their answers with brief explanations or by sending relevant bibliographical references or databases. Answers should refer to current legislation or institutional arrangements, but in case the latter have evolved over time, the Secretariat would appreciate if respondents could indicate which specific features have changed in the box at the end of the questionnaire.

The questionnaire covers all tertiary education institutions, not only universities. This is why the term "university" has been avoided. Although in some countries almost all tertiary education degrees are

[1]Some results for OECD countries using this questionnaire are presented by Oliveira Martins, J. et al. (2007). The Policy Determinants of Investment in Tertiary Education. OECD Economics Department Working Papers, No. 576, OECD Publishing. doi:10.1787/085530578031.

awarded by universities, in many others at least a binary (if not more diversified) system exists, with "universities" denoting those institutions offering the more theoretical, usually longer programmes that lead to entry into PhD programmes or doctoral studies (see question 2).

Practical arrangements

Please use use an electronic version of the questionnaire and contact the ISEG/Lisbon Technical University Team in case you need assistance or for any clarifications or guidance that would make responding easier and more accurate. Contact:

Miguel St. Aubyn,
Professor of Economics,
ISEG/Lisbon Tech University,
Rua Miguel Lupi, 20
P-1249-078 Lisbon (Portugal)

email: mstaubyn@iseg.utl.pt
tel. +351 - 21 392 59 87

Please respond by the end of June 2008.

Thank you!

Please provide a contact person in your country

NAME:

MINISTRY OR GOVERNMENT AGENCY:

COUNTRY:

TELEPHONE NUMBER:

EMAIL ADDRESS:

QUESTIONS

Autonomy of tertiary education institutions

1. Please indicate whether tertiary education institutions have autonomy along the following criteria:

	Public institutions			Private institutions		
	Yes	No	Some[a]	Yes	No	Some[a]
Set course content	☐	☐	☐	☐	☐	☐
Hire and dismiss academic staff	☐	☐	☐	☐	☐	☐
Set salaries	☐	☐	☐	☐	☐	☐
If wages are set by national (or regional) law: Setting non-wage working conditions for academic staff (*e.g.*, teaching load, research and travel budget, number of assistants/support staff, office equipment)	☐	☐	☐	☐	☐	☐
Choose number of students	☐	☐	☐	☐	☐	☐
Select student profiles	☐	☐	☐	☐	☐	☐
Decide on the level of tuition fees	☐	☐	☐	☐	☐	☐
Decide on the level of financial aid and grants	☐	☐	☐	☐	☐	☐
Way of spending budgets to achieve their objectives	☐	☐	☐	☐	☐	☐
Raise funds	☐	☐	☐	☐	☐	☐

[a] "Some" refers to the case where more than 0% but less than 25% of tertiary education institutions enjoy autonomy with respect to the criterion mentioned.

Diversification of tertiary education supply and practices

2. Is the tertiary education system in your country diversified along the following dimensions?

	Yes	No	
Are there academic fields into which entry is restricted or rationed by national/regional regulations (*numerus clausus*)?	☐	☐	
	Yes	**No**	**Some[a]**
In academic fields to which no (sub-)national *numerus clausus* applies, do tertiary education institutions select students on the basis of prior school performance?	☐	☐	☐
Do tertiary education institutions use own entry tests to select students? (Rejection rate ≥ 50%)	☐	☐	☐
Do tertiary education institutions use (sub-)national standardised aptitude tests to select students?[b]	☐	☐	☐
Do tertiary education institutions offer short study programmes (max. duration: 3 years)?	☐	☐	☐
	Yes	**No**	
Are there academic fields for which the final exam and/or the study programme are the same in all tertiary education institutions throughout the country/jurisdiction?	☐	☐	
	Yes	**No**	**Some[a]**
Do tertiary education institutions offer a range of courses within each study programme among which students can choose?	☐	☐	☐
Do tertiary education institutions admit part-time learners, distance-learners, and learners with professional experience (outside the usual enrolment requirements)?	☐	☐	☐

[a] "Some" refers to the case where the action described applies to more than 0% but less than 25% of tertiary education institutions. [b] For example, the SAP (standardised aptitude test) used by many colleges in the United States.

3. Intra- and international mobility results, *inter alia*, from the diversity of study programmes offered. What is the percentage of students enrolled into tertiary education institutions outside their region of high-school graduation? (Average over past 10 years; otherwise please specify year or provide time series)

%

Research in tertiary education institutions

4. Do faculties of tertiary education institutions in your country have a legal (or other formal) obligation to carry out academic research?

	Yes	No
Universities	☐	☐
Other tertiary education institutions	☐	☐

5. What is the share of the total working time academic staff in tertiary education institutions spends on core educational services and research activities taken together?

0 to 50%	50% to 75%	75% to 100%
☐	☐	☐

6. Please indicate the relative importance of core educational services as compared with research activities for the average academic staff member in tertiary education institutions.

	More teaching than research	About equal split	More research than teaching
Universities	☐	☐	☐
Other tertiary education institutions	☐	☐	☐

Accountability

7. How are tertiary education institutions held accountable for performance? [a]

	Core educational services			Research		
	Yes	No	Some[b]	Yes	No	Some[b]
Ministerial oversight [c]	☐	☐	☐	☐	☐	☐
Evaluation by government-funded agency	☐	☐	☐	☐	☐	☐
Evaluation by independent agency	☐	☐	☐	☐	☐	☐
Students' evaluation	☐	☐	☐	☐	☐	☐
Evaluation by other stakeholders	☐	☐	☐	☐	☐	☐
Outside observers (*e.g.*, rankings in news magazines, international organisations)	☐	☐	☐	☐	☐	☐
Not at all	☐			☐		

[a] If applicable, please rank the answers within the "yes" column according to their importance, *e.g.* by assigning 1 to the most important player, 2 to the second most important one etc. [b] "Some" refers to the case where the criterion described applies to more than 0% but less than 25% of tertiary education institutions. [c] If answer is yes, please specify level of government in charge of the oversight: ☐ national ☐ regional/provincial

8. Are the results of quality assessments to be made publicly available? ☐ **Yes** ☐ **No**

Funding of tertiary education institutions

9. Do tertiary education institutions receive separate public funding for educational services and research? ☐ Yes ☐ No

10. Is public funding to tertiary education institutions allocated as a lump sum (block grants) or as an itemised budget?

Core educational services		Research	
☐ lump sum	☐ itemised	☐ lump sum	☐ itemised

11. To what extent does the public funding envelope of tertiary education institutions depend on the following criteria?

	Core educational services[a]			Research[a]		
	irrelevant	One of the funding criteria	Only funding criterion	irrelevant	One of the funding criteria	Only funding criterion
Fixed share in government's tertiary education budget (resulting from law or historical attributions)	☐	☐	☐	☐	☐	☐
Inputs (professors/researchers, size of infrastructure and equipment etc.)	☐	☐	☐	☐	☐	☐
Number of students	☐	☐	☐	☐	☐	☐
Number of graduates and/or completed PhDs	☐	☐	☐	☐	☐	☐
Number of publications	☐	☐	☐	☐	☐	☐
Other outputs	☐	☐	☐	☐	☐	☐
Outcomes (*e.g.* final marks, results of evaluations by external commissions or students; quality-adjusted number of publications)	☐	☐	☐	☐	☐	☐
Negotiated on a contract basis with achievement of objectives being a requirement for future funding	☐	☐	☐	☐	☐	☐
Negotiated (other)	☐	☐	☐	☐	☐	☐

[a] If there is no separate budget for core educational services and research, please fill in only the left half of the table, which then refers to core educational services and research taken together.

12. Do the results of quality assessments have an effect on public funding decisions? ☐ Yes ☐ No

13. The nature and structure of private funding sources influence the governance of tertiary education institutions and may have an impact on how institutions react to changes in market environments. Please indicate the share of the following types of donors in total *private* funding of tertiary education institutions.

	Core educational services[a]				**Research**[a]			
Share	0 to 20%	20 to 50%	50 to 80%	80 to 100%	0 to 20%	20 to 50%	50 to 80%	80 to 100%
Tuition fees	☐	☐	☐	☐	☐	☐	☐	☐
Private households and non-profit organisations	☐	☐	☐	☐	☐	☐	☐	☐
Business	☐	☐	☐	☐	☐	☐	☐	☐
Abroad	☐	☐	☐	☐	☐	☐	☐	☐
Other (please specify)	☐	☐	☐	☐	☐	☐	☐	☐

[a] If there is no separate budget for core educational services and research, please fill in only the left half of the table, which then refers to core educational services and research taken together.

Matching of tertiary qualifications with labour market needs

NB: the matching between tertiary qualifications and labour markets by type of education g beyond the initial purpose of the questionnaire, but it would enable the Secretariat to accurate link between returns and human capital investment. This kind of information ma directly available. Respondents may take some extra time to answer these specific issues a partially (years/sectors) the table below.

14. What is the number of graduates and the percentage of students finding a job ir months after completing their highest tertiary degree (bachelor/master/doctorate) by acade year?

	1991	1995	1999	2003
Total				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				
Economics and business				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				
Law				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				
Social sciences				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				
Humanities, arts and esthetical subjects				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				
Natural science and technological subjects				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				
Health, welfare and sports				
Total number of graduates				
Employment rate [a]				
Unemployment rate [b]				

a) Fraction of total number of graduates. If possible, additionally indicate share of "irrelevant jobs", *i.e.*, jobs for which the higher degree is neither needed nor helpful. b) Fraction of total number of graduates.

Reforms over the past ten years

15. If any of the answers given above have changed due to reforms in the past decade, please briefly indicate them (time and main changes) in the following box:

Major reforms in areas covered by the questionnaire

Appendix D - Data Envelopment Analysis alternative models

TABLE D1: MODEL DEA1 – TEACHING
(RESEARCH IS NOT CONSIDERED)
INPUT ORIENTED DEA

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.450	24	Japan, Romania	0.456	20	Japan
Belgium	0.755	7	Japan, UK	0.726	6	UK, Japan
Bulgaria	0.521	15	Romania, Japan	0.517	17	Japan
Cyprus	1.000	1	Cyprus	0.870	4	Japan
Czech Republic	0.624	10	Romania, Japan	0.618	13	Japan
Denmark	0.537	14	Ireland, Japan, UK	0.637	11	Ireland, Japan, UK
Estonia	0.411	26	UK, Japan	0.360	27	Japan, UK
Finland	0.498	18	Ireland, Japan, UK	0.417	24	Ireland, Japan, UK
France	0.591	12	Japan, UK	0.644	10	Japan, UK
Germany	0.456	23	Romania, Japan	0.445	22	Japan
Greece	0.596	11	Japan, Romania	0.511	18	Japan
Hungary	0.488	20	Romania, Japan	0.466	19	Japan, UK
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.739	8	Japan, Romania	0.636	12	Japan
Japan	1.000	1	Japan	1.000	1	Japan
Latvia	0.544	13	Japan, Romania	0.668	7	Japan, UK
Lithuania	0.294	28	UK, Japan	0.402	25	Japan, UK
Malta	0.639	9	Romania, Japan	0.650	9	Japan
Netherlands	0.515	16	Japan, UK	0.531	15	Ireland, Japan, UK
Poland	0.493	19	Japan, UK	0.542	14	Japan, UK
Portugal	0.461	22	Romania, Japan	0.438	23	Japan
Romania	1.000	1	Romania	0.840	5	Japan
Slovakia	0.466	21	Japan, Romania	0.448	21	Japan, UK
Slovenia	0.898	6	Romania, Japan	0.664	8	Japan
Spain	0.441	25	Japan, Romania	0.389	26	Japan, UK
Sweden	0.335	27	Japan, UK	0.346	28	Japan, Ireland, UK
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.514	17	Japan, UK	0.520	16	Japan, UK

TABLE D2: MODEL DEA1 – RESEARCH
(TEACHING IS NOT CONSIDERED)
OUTPUT ORIENTED DEA

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.256	28	Ireland, Japan	0.302	25	Ireland, Japan
Belgium	0.688	6	Ireland, Japan, UK	0.666	4	Ireland, Japan, UK
Bulgaria	0.313	25	Ireland, Japan, UK	0.343	20	Ireland, Japan, UK
Cyprus	1.000	1	Cyprus	0.235	28	Ireland, Japan
Czech Republic	0.298	26	Ireland, Japan, UK	0.352	18	Ireland, Japan, UK
Denmark	0.525	10	Ireland, Japan	0.614	5	Ireland, Japan, UK
Estonia	0.437	12	Ireland, Japan	0.315	24	Ireland, Japan
Finland	0.626	7	Ireland	0.519	8	Ireland
France	0.529	9	Ireland, Japan	0.599	6	Ireland, Japan, UK
Germany	0.353	18	Ireland, Japan	0.316	23	Ireland, Japan
Greece	0.273	27	Japan, UK	0.274	27	Ireland, UK
Hungary	0.323	22	Ireland, Japan	0.333	21	Ireland, Japan, UK
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.333	21	Japan, UK	0.369	17	Japan, UK
Japan	1.000	1	Japan	1.000	1	Japan,
Latvia	0.346	20	Ireland, Japan, UK	0.469	12	Japan, UK
Lithuania	0.368	17	Ireland, Japan	0.398	15	Ireland
Malta	0.429	14	Ireland, Japan	0.480	11	Ireland, Japan, UK
Netherlands	0.508	11	Ireland, Japan	0.503	9	Ireland, Japan
Poland	0.431	13	Ireland, Japan	0.482	10	Ireland, Japan, UK
Portugal	0.350	19	Ireland, Japan	0.325	22	Ireland, Japan
Romania	1.000	1	Romania	0.545	7	Japan, UK
Slovakia	0.316	23	Ireland, Japan	0.346	19	Ireland, Japan
Slovenia	0.587	8	Japan, UK	0.410	13	Japan, UK
Spain	0.315	24	Ireland, UK	0.302	25	Ireland, Japan
Sweden	0.396	15	Ireland, Japan	0.409	14	Ireland
United Kingdom	1.000	1	UK	1.000	1	UK,
United States	0.381	16	Ireland, Japan, UK	0.382	16	Ireland, UK

TABLE D3: MODEL DEA1
(WITHOUT ROMANIA AND CYPRUS)
INPUT ORIENTED DEA

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.777	11	UK, Netherlands, Japan	0.963	9	Neth., Denmark, Japan
Belgium	0.846	8	Japan, UK	0.973	8	Denmark, UK, Japan
Bulgaria	0.533	19	Japan	0.517	19	Japan
Czech Republic	0.652	14	Japan	0.618	16	Japan
Denmark	0.816	9	UK, Netherlands, Japan	1.000	1	Denmark
Estonia	0.411	25	Japan, UK	0.360	26	UK, Japan
Finland	1.000	1	Finland	0.975	7	UK, Ireland, Sweden
France	0.591	17	Japan, UK	0.644	14	UK, Japan
Germany	0.643	15	Netherlands, UK, Japan	0.644	14	Neth., Japan, Denmark
Greece	0.621	16	Japan	0.511	20	Japan
Hungary	0.497	20	Japan	0.466	21	Japan, UK
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.808	10	UK, Japan	0.685	10	UK, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Latvia	0.552	18	Japan	0.668	11	Japan, UK
Lithuania	0.294	26	UK, Japan	0.402	24	UK, Japan
Malta	0.657	12	Japan	0.650	13	Japan
Netherlands	1.000	1	Netherlands	1.000	1	Neth.
Poland	0.493	21	Japan, UK	0.542	18	Japan,UK
Portugal	0.471	23	Japan	0.438	23	Japan
Slovakia	0.481	22	Japan	0.448	22	UK, Japan
Slovenia	0.928	7	Japan	0.664	12	Japan
Spain	0.441	24	Japan	0.389	25	Japan, UK
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.655	13	Japan, UK	0.605	17	Japan, UK

TABLE D4: MODEL DEA1
(WITHOUT ROMANIA AND CYPRUS)
OUTPUT ORIENTED DEA

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.761	9	UK, Netherlands	0.962	9	Neth., Denmark, Japan
Belgium	0.839	8	UK, Netherlands	0.972	8	Denmark, UK, Japan
Bulgaria	0.313	24	Ireland, Japan, UK	0.343	24	Ireland, Japan, UK
Czech Republic	0.298	25	Ireland, Japan, UK	0.352	22	Ireland, UK, Japan
Denmark	0.874	7	UK, Sweden, Netherlands	1.000	1	Denmark
Estonia	0.460	15	UK, Ireland, Japan	0.366	21	UK, Ireland, Japan
Finland	1.000	1	Finland	0.996	7	Ireland, Sweden, UK
France	0.566	14	UK, Ireland, Japan	0.599	11	Ireland, Japan, UK
Germany	0.649	10	Netherlands, Japan, Sweden	0.660	10	Sweden, Japan, Neth.
Greece	0.273	26	UK, Japan	0.294	26	UK, Ireland, Sweden
Hungary	0.323	22	Ireland, Japan	0.333	25	Ireland, UK, Japan
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.627	11	UK, Japan	0.506	13	UK, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Latvia	0.346	21	Ireland, Japan, UK	0.469	16	UK, Japan
Lithuania	0.368	19	Japan, Ireland	0.398	18	Ireland
Malta	0.429	17	Ireland, Japan	0.480	15	Ireland, Japan, UK
Netherlands	1.000	1	Netherlands	1.000	1	Neth.
Poland	0.431	16	Japan, Ireland	0.482	14	Ireland, UK, Japan
Portugal	0.365	20	UK, Ireland, Japan	0.376	20	UK, Ireland, Japan
Slovakia	0.316	23	Japan, Ireland	0.346	23	Japan, Ireland
Slovenia	0.593	13	UK, Japan	0.414	17	UK, Japan
Spain	0.382	18	UK, Finland, Ireland	0.382	19	UK, Ireland, Japan
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.598	12	UK, Netherlands	0.550	12	UK, Denmark

TABLE D5: MODEL DEA2 – TEACHING
(RESEARCH IS NOT CONSIDERED)
INPUT ORIENTED DEA

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.374	22	Japan	0.437	19	Japan
Belgium	0.691	5	Ireland, Japan	0.558	7	Ireland, Japan
Bulgaria	0.426	21	Japan	0.486	16	Japan
Czech Republic	0.605	7	Japan	0.531	11	Japan
Denmark	0.436	20	Ireland, Japan	0.419	22	Ireland, Japan
Estonia	0.519	13	Ireland, Japan	0.551	9	Ireland, Japan
Finland	0.520	12	Ireland, Japan	0.430	20	Ireland, Japan
France	0.617	6	Ireland, Japan	0.579	5	Ireland, Japan
Germany	0.495	16	Japan	0.491	15	Japan
Greece	0.516	15	Japan	0.423	21	Japan
Hungary	0.467	19	Japan	0.471	18	Ireland, Japan
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.570	9	Japan	0.553	8	Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	0.529	11	Ireland, Japan	0.542	10	Ireland, Japan
Malta	0.860	4	Japan	0.867	3	Japan
Netherlands	0.517	14	Ireland, Japan	0.524	13	Ireland, Japan
Poland	0.553	10	Ireland, Japan	0.502	14	Ireland, Japan
Portugal	0.490	17	Japan	0.486	16	Japan
Slovakia	0.598	8	Japan	0.564	6	Ireland, Japan
Slovenia	0.371	23	Japan	0.394	23	Japan
Spain	0.490	17	Japan	0.525	12	Ireland, Japan
Sweden	0.363	24	Ireland, Japan	0.388	24	Ireland, Japan
United Kingdom	0.948	3	Ireland, Japan	0.778	4	Ireland, Japan
United States	0.335	25	Ireland, Japan	0.337	25	Ireland, Japan

TABLE D6: MODEL DEA2 – TEACHING
(RESEARCH IS NOT CONSIDERED)
OUTPUT ORIENTED DEA

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.225	24	Ireland, Japan	0.213	24	Ireland
Belgium	0.657	4	Ireland, Japan	0.477	7	Ireland
Bulgaria	0.284	21	Ireland, Japan	0.233	21	Ireland, Japan
Czech Republic	0.313	20	Ireland, Japan	0.248	19	Ireland, Japan
Denmark	0.486	9	Ireland	0.520	5	Ireland
Estonia	0.461	12	Ireland, Japan	0.337	13	Ireland, Japan
Finland	0.626	5	Ireland	0.519	6	Ireland
France	0.571	7	Ireland, Japan	0.404	9	Ireland, Japan
Germany	0.335	16	Ireland, Japan	0.224	23	Ireland, Japan
Greece	0.273	22	Ireland, Japan	0.205	25	Ireland
Hungary	0.330	18	Ireland, Japan	0.276	18	Ireland
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.266	23	Ireland, Japan	0.289	17	Ireland, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	0.467	11	Ireland, Japan	0.398	11	Ireland
Malta	0.597	6	Ireland, Japan	0.698	3	Ireland, Japan
Netherlands	0.468	10	Ireland, Japan	0.403	10	Ireland
Poland	0.495	8	Ireland, Japan	0.395	12	Ireland
Portugal	0.334	17	Ireland, Japan	0.241	20	Ireland, Japan
Slovakia	0.371	15	Ireland, Japan	0.336	14	Ireland, Japan
Slovenia	0.213	25	Ireland, Japan	0.226	22	Ireland
Spain	0.423	13	Ireland, Japan	0.308	15	Ireland, Japan
Sweden	0.383	14	Ireland	0.409	8	Ireland
United Kingdom	0.941	3	Ireland, Japan	0.688	4	Ireland
United States	0.319	19	Ireland	0.303	16	Ireland

TABLE D7: MODEL DEA2 – RESEARCH
(TEACHING IS NOT CONSIDERED)
INPUT ORIENTED DEA.

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.707	9	UK, Japan	0.904	5	Sweden, Japan
Belgium	0.844	7	UK, Japan	0.861	8	Sweden, Japan
Bulgaria	0.426	23	Japan	0.486	17	Japan
Czech Republic	0.605	12	Japan	0.531	14	Japan
Denmark	0.656	10	Netherlands, UK	0.721	9	Sweden, Japan
Estonia	0.485	21	Japan	0.515	15	Japan
Finland	0.937	5	Sweden, Netherlands	0.866	7	Sweden, Japan
France	0.490	18	Japan	0.468	19	Japan
Germany	0.724	8	UK, Japan	0.716	10	Sweden, Japan
Greece	0.516	15	Japan	0.423	23	Japan
Hungary	0.467	22	Japan	0.444	20	Japan
Ireland	0.421	24	Japan, UK	0.640	11	Sweden, Japan
Italy	0.610	11	UK, Japan	0.618	12	Sweden, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	0.527	14	Japan	0.433	22	Japan
Malta	0.860	6	Japan	0.867	6	Japan
Netherlands	1.000	1	Netherlands	0.988	3	Sweden, Japan
Poland	0.516	15	Japan	0.403	24	Japan
Portugal	0.490	18	Japan	0.486	17	Japan
Slovakia	0.598	13	Japan	0.547	13	Japan
Slovenia	0.371	25	Japan	0.394	25	Japan
Spain	0.490	18	Japan	0.500	16	Japan
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	0.962	4	Sweden, Japan
United States	0.492	17	UK, Japan	0.438	21	Sweden, Japan

TABLE D8: MODEL DEA2 – RESEARCH
(TEACHING IS NOT CONSIDERED)
OUTPUT ORIENTED DEA..

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.694	8	Sweden, Netherlands	0.886	5	Sweden, Japan
Belgium	0.815	6	UK, Netherlands	0.839	7	Sweden, Japan
Bulgaria	0.031	25	Netherlands, UK	0.049	25	Sweden, Japan
Czech Republic	0.166	20	UK, Japan	0.215	19	Sweden, Japan
Denmark	0.711	7	Sweden	0.731	8	Sweden
Estonia	0.247	16	UK, Japan	0.331	14	Sweden, Japan
Finland	0.992	5	Sweden	0.873	6	Sweden
France	0.329	14	UK, Japan	0.320	15	Sweden, Japan
Germany	0.664	9	UK, Japan	0.658	9	Sweden, Japan
Greece	0.193	18	UK, Japan	0.258	18	Sweden, Japan
Hungary	0.123	21	UK, Netherlands	0.210	20	Sweden, Japan
Ireland	0.353	12	Sweden, Netherlands	0.572	10	Sweden, Japan
Italy	0.509	10	UK, Japan	0.527	11	Sweden, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	0.040	24	UK, Japan	0.051	24	Sweden, Japan
Malta	0.256	15	UK, Japan	0.135	21	Sweden, Japan
Netherlands	1.000	1	Netherlands	0.986	3	Sweden, Japan
Poland	0.100	23	UK, Japan	0.110	23	Sweden, Japan
Portugal	0.184	19	UK, Japan	0.266	17	Sweden, Japan
Slovakia	0.120	22	UK, Japan	0.120	22	Sweden, Japan
Slovenia	0.206	17	Sweden, Netherlands	0.269	16	Sweden, Japan
Spain	0.343	13	UK, Japan	0.380	12	Sweden, Japan
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	0.955	4	Sweden, Japan
United States	0.472	11	Sweden, Netherlands	0.371	13	Sweden

Model DEA3 is an alternative DEA model where the input is real spending in PGD institutions measured in purchasing power standards per head of population. Results are less reliable than those presented in the main text as there is no control for differences in wages across countries.

TABLE D9: MODEL DEA3
(INPUT IS REAL SPENDING IN PPS)
INPUT ORIENTED DEA.

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.621	17	UK, Japan	0.837	13	Sweden, Japan
Belgium	0.789	11	UK, Japan	0.851	12	Sweden, UK, Japan
Bulgaria	1.000	1	Bulgaria	1.000	1	Bulgaria
Czech Republic	0.706	14	Bulgaria, Japan	0.624	19	Japan, Bulgaria
Denmark	0.603	18	Finland, UK	0.694	16	Sweden, UK, Japan
Estonia	0.715	13	UK, Lith., Japan	0.858	10	Japan, UK, Bulgaria
Finland	1.000	1	Finland	0.989	7	Sweden, UK, Ireland
France	0.535	21	UK, Lith., Japan	0.552	21	Bulgaria, UK, Ireland
Germany	0.688	15	UK, Japan	0.711	15	Sweden, Japan
Greece	0.512	23	Bulgaria, Japan	0.438	24	Japan, Bulgaria
Hungary	0.645	16	Bulgaria, Japan	0.682	17	UK, Bulgaria, Japan
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.568	19	UK, Japan	0.627	18	Sweden, Japan
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	1.000	1	Lith.	1.000	1	Lith.
Malta	0.777	12	Bulgaria, Japan	0.854	11	Ireland, Lith., Bulgaria
Netherlands	0.974	9	Finland, UK	0.919	9	Sweden, UK, Japan
Poland	1.000	1	Poland	0.959	8	Ireland, Lith., Bulgaria
Portugal	0.551	20	Japan, Bulgaria	0.601	20	Japan, Bulgaria
Slovakia	0.833	10	Bulgaria, Japan	0.781	14	Ireland, Bulgaria, UK
Slovenia	0.380	24	Bulgaria, Japan	0.459	23	Japan, Bulgaria
Spain	0.535	21	Japan, Lith., Bulgaria	0.548	22	UK, Bulgaria, Japan
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.355	25	UK, Japan	0.330	25	Sweden, UK, Japan

TABLE D10: MODEL DEA3
(INPUT IS REAL SPENDING IN PPS)
OUTPUT ORIENTED DEA.

	Period 1 - 1998-2001			Period 2 - 2002-2005		
	Coef.	**Rank**	**Peers**	**Coef.**	**Rank**	**Peers**
Austria	0.667	14	Finland, UK	0.823	14	Japan, Sweden
Belgium	0.801	10	Finland, UK	0.842	11	Japan, Sweden, UK
Bulgaria	1.000	1	Bulgaria	1.000	1	Bulgaria
Czech Republic	0.479	23	Japan, Lith., UK	0.518	21	Bulgaria, Ireland, UK
Denmark	0.749	11	Finland, Ireland	0.897	10	Ireland, Sweden
Estonia	0.719	12	Ireland, Poland, UK	0.830	13	Bulgaria, Japan, UK
Finland	1.000	1	Finland	0.997	7	Ireland, Sweden, UK
France	0.601	18	Ireland, Poland, UK	0.533	19	Bulgaria, Ireland, UK
Germany	0.640	15	UK,	0.680	16	Japan, Sweden
Greece	0.359	24	Ireland, Poland, UK	0.353	25	Bulgaria, Japan, UK
Hungary	0.604	17	Ireland, Poland, UK	0.647	17	Bulgaria, Ireland, UK
Ireland	1.000	1	Ireland	1.000	1	Ireland
Italy	0.490	20	Japan, UK	0.588	18	Japan, Sweden, UK
Japan	1.000	1	Japan	1.000	1	Japan
Lithuania	1.000	1	Lith.	1.000	1	Lith.
Malta	0.638	16	Japan, Lith., UK	0.835	12	Bulgaria, Ireland, Lith.
Netherlands	0.980	9	Finland, UK	0.914	9	Japan, Sweden, UK
Poland	1.000	1	Poland	0.955	8	Bulgaria, Ireland, Lith.
Portugal	0.487	21	Ireland, Poland, UK	0.525	20	Bulgaria, Japan, UK
Slovakia	0.675	13	Japan, Lith., UK	0.758	15	Bulgaria, Ireland, Lith.
Slovenia	0.288	25	Ireland, Poland, UK	0.396	24	Japan, Sweden, UK
Spain	0.512	19	Ireland, Poland, UK	0.497	22	Bulgaria, Japan, UK
Sweden	1.000	1	Sweden	1.000	1	Sweden
United Kingdom	1.000	1	UK	1.000	1	UK
United States	0.484	22	Finland, Ireland	0.484	23	Ireland, Sweden

Appendix E - Stochastic Frontier Analysis alternative models

TABLE E1: SFA ESTIMATION RESULTS WITHOUT STAFF POLICY
(DEPENDENT VARIABLE: COST IN PERCENTAGE OF GDP)

	Coefficient	**Standard-Error**	***t*-ratio**
Cost function:			
constant	-1.410	232.4	-0.006065
lwgrad	0.2669	0.04363	6.118
lwpub	0.2568	0.02584	9.941
Inefficiency:			
constant	5.030	232.4	0.02164
evaluation	-0.03978	0.01388	-2.867
funding rules	-0.05180	0.01743	-2.973
PISA2000	-0.007369	0.0009321	-7.906
$\hat{\sigma}_\varepsilon^2$	0.03646	0.004091	8.912
γ	0.2229		
LR statistic (γ=0)	57.93		

Alternative stochastic frontier model:

$$\ln c_{it} = \beta_0 + \beta_1 \ln wage_{it} + \beta_2 \ln wpub_{it} + \beta_3 \ln wgrad_{it} + \eta_{it} + \varepsilon_{it},$$

- c_{it} is the total cost with PGD institutions in country *i*, measured in real purchasing power standards euros *per capita;*
- $wage_{it}$ is an input price, the average wage in the services sector, measured in real purchasing power standards euros;
- $wgrad_{it}$, one of the considered outputs, are student graduations weighted by quality and *per capita*;
- $wpub_{it}$, the other output, are publications weighted by citations *per capita*.

TABLE E2: ALTERNATIVE SFA MODEL
ESTIMATION RESULTS
(DEPENDENT VARIABLE: REAL COST IN PPS)

	Coefficient	**Standard-Error**	***t*-ratio**
Cost function:			
constant	-4.085	0.3918	-10.43
lwage	0.2177	0.4958	4.390
lwgrad	0.3046	0.04004	7.608
lwpub	0.5260	0.1006	5.227
Inefficiency:			
constant	0.9547	0.2502	3.815
evaluation	-0.07312	0.02674	-2.734
funding rules	-0.05543	0.03859	-1.436
$\hat{\sigma}_{\varepsilon}^{2}$	0.0511	0.007888	6.482
γ	0.2359	0.1891	1.246
LR statistic (γ=0)	15.17		

TABLE E3: ALTERNATIVE SFA MODEL, EFFICIENCY SCORES

	1998	1999	2000	2001	2002	2003	2004	2005	Average	Ranking (average)
United Kingdom	0.909	0.912	0.915	0.915	0.908	0.912	na	na	0.912	1
Netherlands	0.887	0.870	0.869	0.863	0.869	0.871	0.875	0.874	0.872	2
Japan	0.873	0.865	0.863	0.862	0.865	0.851	0.845	0.854	0.860	3
Hungary	0.847	0.844	0.848	0.858	0.848	0.843	0.873	0.877	0.855	4
Germany	0.847	0.845	0.845	0.844	0.840	0.832	0.837	0.844	0.842	5
Italy	0.839	0.828	0.822	0.812	0.817	0.821	0.855	0.856	0.831	6
Ireland	0.831	0.814	0.794	0.819	0.826	0.848	0.853	0.856	0.830	7
France	0.824	0.826	0.824	0.826	0.828	0.807	0.806	0.812	0.819	8
Portugal	0.802	0.805	0.808	0.805	0.824	0.814	na	na	0.810	9
Spain	0.826	0.825	0.810	0.805	0.802	0.801	0.803	0.804	0.810	10
Belgium	na	0.750	0.801	0.798	0.803	0.815	0.824	0.827	0.802	11
Sweden	0.766	0.762	0.761	0.768	0.766	0.764	0.770	0.784	0.768	12
Austria	0.723	0.708	0.749	0.759	0.756	0.770	0.759	0.752	0.747	13
Czech Republic	0.744	0.689	0.757	0.755	0.752	0.750	0.751	0.752	0.744	14
Slovakia	na	0.742	0.746	0.723	0.728	0.723	0.697	0.721	0.726	15
Finland	0.739	0.724	0.722	0.724	0.720	0.724	0.719	0.725	0.725	16
Denmark	na	na	0.688	0.677	0.672	0.698	0.696	0.705	0.689	17
United States	0.703	0.695	0.693	0.679	0.671	0.669	0.690	0.684	0.686	18
Greece	na	na	na	0.609	0.604	na	0.589	0.584	0.597	19

Appendix F - Effectiveness alternative models

TABLE F1: TERTIARY SPENDING, EFFICIENCY AND LABOUR PRODUCTIVITY
REGRESSION RESULTS (EU COUNTRIES ONLY, ALTERNATIVE SFA SCORES)

Equation		(11), alternative SFA
lprod98	coef.	-0.370***
	std. dev.	(0.120)
	P-value	0.002
inv	coef.	0.132
	std. dev.	(0.699)
	P-value	0.850
s or eff.s	coef.	0.983
	std. dev.	(4.844)
	P-value	0.839
Obs		17
R^2		0.579

Sources and notes as under Table 16.

Efficiency scores are those from table E3.

TABLE F2: TERTIARY SPENDING, EFFICIENCY AND LABOUR PRODUCTIVITY
REGRESSION RESULTS (ALL COUNTRIES)

Equation		(10)	(11), DEA1	(11), DEA2	(10)	(11), alternative SFA	(11), SFA
lprod98	coef.	-0.483***	-0.488***	-0.434***	-0.326***	-0.333***	-0.331***
	std. dev.	(0.080)	(0.084)	(0.090)	(0.112)	(0.114)	(0.113)
	P-value	0.000	0.000	0.000	0.004	0.004	0.003
inv	coef.	0.739	0.762	0.954	0.208	0.050	0.140
	std. dev.	(0.693)	(0.690)	(0.708)	(0.615)	(0.703)	(0.694)
	P-value	0.286	0.269	0.178	0.735	0.943	0.841
s or eff.s	coef.	3.456	2.763	4.473	1.494	-0.108	1.215
	std. dev.	(2.937)	(2.677)	(3.593)	(2.507)	(4.607)	(5.730)
	P-value	0.239	0.302	0.213	0.551	0.981	0.832
Obs		28	28	25	19	19	19
R^2		0.709	0.708	0.658	0.524	0.520	0.521

Sources and notes as under Table 16.

TABLE F3: TERTIARY SPENDING, EFFICIENCY, CAPITAL DEEPENING AND LABOUR PRODUCTIVITY REGRESSION RESULTS (EU COUNTRIES ONLY, ALTERNATIVE SFA SCORES)

Equation		(13), alternative SFA
lprod98	coef.	0.043
	std. dev.	(0.140)
	P-value	0.758
kl05/kl98	coef.	1.191***
	std. dev.	(0.360)
	P-value	0.001
s or eff.s	coef.	6.341
	std. dev.	(4.426)
	P-value	0.152
Obs		14
R^2		0.492

Sources and notes as under Table 17.

Efficiency scores are those from table E3.

TABLE F4: TERTIARY SPENDING, EFFICIENCY, CAPITAL DEEPENING AND LABOUR PRODUCTIVITY REGRESSION RESULTS (ALL COUNTRIES)

Equation		(12)	(13), DEA1	(13), DEA2	(13), alternative SFA	(13), SFA
lprod98	coef.	-0.029	-0.031	-0.011	-0.026	-0.029
	std. dev.	(0.111)	(0.104)	(0.105)	(0.113)	(0.110)
	P-value	0.795	0.768	0.915	0.815	0.793
kl05/kl98	coef.	0.983***	1.065***	1.174***	1.019***	1.092***
	std. dev.	(0.301)	(0.293)	(0.298)	(0.316)	(0.301)
	P-value	0.001	0.000	0.000	0.001	0.000
s or eff.s	coef.	3.298	3.706*	5.023***	4.646	6.709*
	std. dev.	(2.281)	(1.919)	(1.914)	(3.483)	(3.532)
	P-value	0.148	0.053	0.009	0.182	0.058
Obs		16	16	16	16	16
R^2		0.484	0.520	0.552	0.473	0.511

Sources and notes as under Table 17.

TABLE F5: TERTIARY SPENDING, EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY REGRESSION RESULTS (EU COUNTRIES ONLY, ALTERNATIVE SFA SCORES)

Equation		(14), alternative SFA
s or eff.s	coef.	5.997
	std. dev.	4.669
	P-value	0.199
Obs		14
R^2		0.108

Sources and notes as under Table 18.

Efficiency scores are those from table E3.

TABLE F6: TERTIARY SPENDING, EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY REGRESSION RESULTS (ALL COUNTRIES)

Equation		(14)	(15) DEA1	(15) DEA2	(15) alternative SFA	(15) SFA
s or eff.s	coef.	3.457	3.950*	4.745**	4.180	5.986
	std. dev.	2.452	2.091	2.097	3.796	4.031
	P-value	0.159	0.059	0.024	0.271	0.138
Obs		16	16	16	16	16
R^2		0.097	0.172	0.195	0.063	0.115

Sources and notes as under Table 18.

TABLE F7: EFFICIENCY IN TERTIARY SPENDING AND UNEMPLOYMENT RISK OF ADULTS
REGRESSION RESULTS (EU COUNTRIES ONLY, ALTERNATIVE SFA SCORES)

		alternative SFA
gradshare	coef.	0.022**
	std. dev.	(0.009)
	P-value	0.011
U2564	coef.	-0.575***
	std. dev.	(0.092)
	P-value	0.000
eff	coef.	-0.005
	std. dev.	(0.030)
	P-value	0.868
Obs		17
R^2		0.725

Sources and notes as under Table 19.

Efficiency scores are those from table E3.

TABLE F8: EFFICIENCY IN TERTIARY SPENDING AND UNEMPLOYMENT RISK OF ADULTS
REGRESSION RESULTS (ALL COUNTRIES)

		DEA1	DEA2	alternative SFA	SFA
gradshare	coef.	0.023***	0.022**	0.020**	0.022***
	std. dev.	(0.008)	(0.009)	(0.009)	(0.008)
	P-value	0.004	0.011	0.020	0.005
U2564	coef.	-0.595***	-0.661***	-0.527***	-0.592***
	std. dev.	(0.080)	(0.077)	(0.103)	(0.116)
	P-value	0.000	0.000	0.000	0.000
eff	coef.	0.006	-0.007	0.011	-0.028
	std. dev.	(0.011)	(0.009)	(0.032)	(0.021)
	P-value	0.566	0.434	0.719	0.179
Obs		28	25	19	19
R^2		0.800	0.790	0.695	0.710

Sources for EU countries and notes as under Table 19. For the USA and Japan, variable *gradshare* is an average of years 1999 and 2006, collected respectively from OECD(2001) and OECD(2008); the unemployment rates are 2000-2006 averages, from OECD(2008) in the case of *U2564ter* and *U2564sec*, and from *stats.oecd.org* in the case of *U2564*.

TABLE F9: EFFICIENCY IN TERTIARY SPENDING AND UNEMPLOYMENT RISK OF YOUNG WORKERS
REGRESSION RESULTS (EU COUNTRIES ONLY, ALTERNATIVE SFA SCORES)

		alternative SFA
gradshare	coef.	0.023
	std. dev.	(0.029)
	P-value	0.424
U2564	coef.	-0.532**
	std. dev.	(0.226)
	P-value	0.019
eff	coef.	-0.096
	std. dev.	(0.105)
	P-value	0.364
Obs		17
R^2		0.179

Sources and notes as under Table 20.

Efficiency scores are those from table E3.