The funding and efficiency of higher education in Croatia and Slovenia: a non-parametric comparison

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THE FUNDING AND EFFICIENCY OF HIGHER EDUCATION IN CROATIA AND SLOVENIA: A NON-PARAMETRIC COMPARISON

ABSTRACT

The paper applies a non-parametric approach, i.e. data envelopment analysis (DEA), to assess the relative technical efficiency of higher education across countries, with a particular focus on Croatia and Slovenia. When estimating the efficiency frontier we focus on measures of quantities outputs/outcomes. The results show that the relatively high public expenditure per student in Croatia could have resulted in a relatively better performance regarding the outputs/outcomes, i.e. a higher rate of higher education school enrolment, a greater rate of labor force with a higher education and a lower rate of the unemployed who have a tertiary education. On the other hand, regardless of the input-output/outcome mix, the higher education system in Slovenia is shown to have a much higher level of efficiency compared to both Croatia and many other comparable EU and OECD countries.

Key words: higher education, funding, efficiency, DEA, Croatia, Slovenia, EU, OECD

JEL classification: I21, J24, H52

1. INTRODUCTION

It is acknowledged around the world that investing in higher education is a good thing for the economy and society. Greater investment in universities increases the quality and quantity of highly educated graduates. Tertiary

education[1] covers a wide range of programs and overall serves as an indicator of the advanced skills produced by different countries. The attainment of an upper secondary education has become the norm in most countries today. In addition, the majority of students are graduating from upper secondary programs designed to provide access to tertiary education, in turn leading to increased enrolments at this higher level. Countries with high graduation rates at the tertiary level are also those most likely to develop or maintain a highly skilled labor force (OECD, 2009a, 64). The emerging knowledge-based information society requires a large supply of highly skilled people. There is strong demand for tertiary graduates (especially in the fields of science and engineering, along with other fields like languages and economics) in the economy. The characteristics of the higher education (HE) sector make it difficult to measure efficiency: it does not make a profit; there is an absence of output and input prices; and higher education institutions (HEIs) produce multiple outputs from multiple inputs (Johnes, 2006, 273).

Moreover, tight budgets and demanding citizens are increasingly pressuring governments to show they are giving good value for money. Providing information about public sector performance can satisfy the public's need to know and can also be a useful tool for governments to evaluate their performance. In this respect, the efficiency of higher education systems in Croatia and Slovenia is computed using the non-parametric approach of data envelopment analysis (DEA) to capture the different dimensions of two systems in one rating and to measure their relative efficiency. The paper assesses the relative efficiency of government spending on higher education. The performance of higher education is measured by how well it transforms inputs into outputs. This is the first time DEA estimations have been used to measure the performance of HE systems in these two countries on the macroeconomic level by using a wide range of inputs and outputs/outcomes.

The paper is divided into four main parts. After the introduction, the system of higher education in Croatia and Slovenia, including a descriptive analysis of the main input and output/outcome variables, is briefly summarized in the second part. The third part clarifies non-parametric methods for measuring higher education performance and examines efficiency effects of higher education attainment and reports the results. Conclusions regarding the efficiency of the Croatian and Slovenian higher education sectors are drawn in the fourth part.

2. THE HIGHER EDUCATION SYSTEM IN CROATIA AND SLOVENIA – THE INPUT AND OUTPUT ANALYSIS

[1] The levels of the tertiary education or higher education system are divided in this article according to the International Standard Classification of Education (ISCED), (Unesco, 2010).

Croatian GDP per capita has been relatively low compared to Slovenian or other European countries. One of the many explanations of this difference could be the effectiveness and efficiency of the country's education system. From this perspective, universities generate spill-over effects from their academic research and teaching, thereby stimulating economic growth (Audretsch et al., 2003). Indeed, the close nexus between the university system and economic growth has seen significant attention being paid to the efficiency and quality of Croatian universities. The majority of Croatian and Slovenian universities are government-owned and largely funded by the Ministry of Education and Science[2]. Universities are autonomous bodies established by legislation allowing considerable freedom in their activities. The next section describes the Croatian and Slovenian tertiary systems in more detail.

2.1. The Higher Education Systems of Croatia and Slovenia

Tertiary education (TE) institutions in Croatia encompass universities, polytechnics and schools of professional higher education. Universities may include faculties and academies of arts as legal entities, and may establish a number of other constituent units (departments, institutes etc.). In contrast, polytechnics and professional higher education schools may not establish other TE institutions (MSES, 2007, 33). There are seven public universities and two private universities and 16 private two-, three- or four-year colleges, polytechnics, or academic programs. The central government funds public tertiary education, although management is fully decentralized to the level of individual institutions (WB, 2008a, 107-109). On the other hand, the higher education system in Slovenia is currently based on four universities with 49 faculties, three art academies or professional colleges, and 30 individual higher education institutions generally established as private institutions. The funds for financing academic activity are allocated from the national budget as aggregate funds for a university or an independent higher education institution (integral financing) and take into consideration the field of study and the numbers of enrolled students and graduates from regular first- or second-degree studies (MHEST, 2010a).

Education expenditure in both countries is financed by two distinct types of funding: public funding (public expenditure) and private funding. In all EU countries, public financing accounts for at least 75% of education expenditure when taking all education levels together (Eurostat, 2009, 129). However, since the early 1980s changes in the direction of diversified

[2] Observing the higher education institutions as a whole, the ratio of public funds used exceeds 70%, in extreme cases – mainly in Scandinavia – it can reach even 97-98%. It is fair to ask why the state finances universities and colleges to such a high extent, that is, why the state should have a role in higher education (Tóth, 2008, 79).

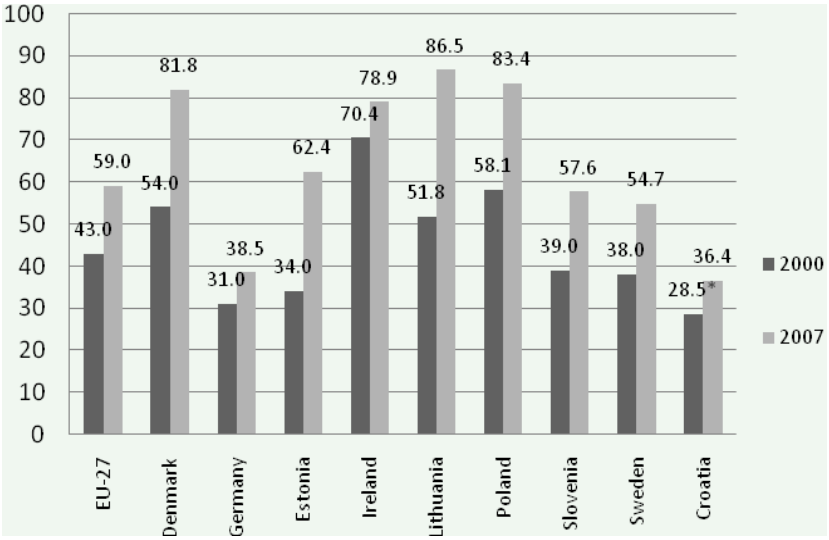
sources have been observed, with an emphasis on student contributions (Bevc, Uršič, 2008, 233). Namely, higher education has expanded and today is in need of better quality. The OECD believes that graduates should contribute to the cost of their tuition – balanced by measures to support students from poor backgrounds (OECD, 2006). The amounts allocated to institutions often only partly cover tuition costs[3] at the ISCED level 5. A distinction may be drawn between two major categories of contribution that are sometimes combined, namely administrative fees and tuition fees. It should be noted that the current trend in Europe regarding contributions to tertiary education is to apply tuition fees. However, Slovenia was to abolish the payment of all tuition fees for ISCED level 5 programs by 2009. Where tuition fees have to be paid by state-subsidized students, they range from under PPS EUR 200 (for some programs in Belgium) to over PPS EUR 1,000 for all programs at ISCED level 5 in the Netherlands and the United Kingdom (except Scotland) (Eurostat, 2009, 144). There is, to use an example, no tuition fee in Scandinavia (the principle of the welfare state) because it has not been discussed (Bevc, Uršič, Čok, 2010, 38).

The total number of tertiary graduates has grown in the EU-27 since 2000 by 35% or 4.3% per year and hence twice as fast as the general student population. Of course, one reason for this is the Bologna Process, with a higher share of students taking second degrees (European Commission, 2009, 59). In both of countries higher education institutions provide degree study programs which are established under Bologna Declaration. Actually, the number of students admitted is restricted due to the limited number of places available in specific study programmes. The tertiary education system in both countries has begun to function according to the Bologna Process[4] in the academic year 2005/2006. Flexible and dynamic tertiary institutions are major players in integrating the tertiary system into the European Higher Education Area (EHEA) and the European Research Area (ERA) (MoSES, 2007, 22). Resource problems have arisen during implementation so that it remains to be seen if the Bologna process can tackle chronic problems of high tertiary drop-out rates and long completion periods. The overall growth in graduates was particularly strong (over 10% per year) in Romania, the Czech Republic and Slovakia in the 2000-2007 period (see Figure 1).

Figure 1. Tertiary graduates (by ISCED levels 5 and 6 per 1,000 population aged 20-29/25-34), 2000-2007

[3] Tuition fees are generally higher than other forms of contribution: the annual administrative fees reported are never above the PPS EUR 200 (Eurostat, 2009, 145).

[4] The Bologna Process is an intergovernmental initiative launched in 1999 which aims to create a European Higher Education Area (EHEA) by 2010 and to promote the European system of higher education worldwide. Those programs consist of three main cycles. First Bologna cycle leads to professional/academic higher education. Second Bologna cycle leads to master education and third last one leads to Doctorate of science. See more detailed: European Higher Education Area (1999) *The Bologna Declaration of 19 June 1999*.

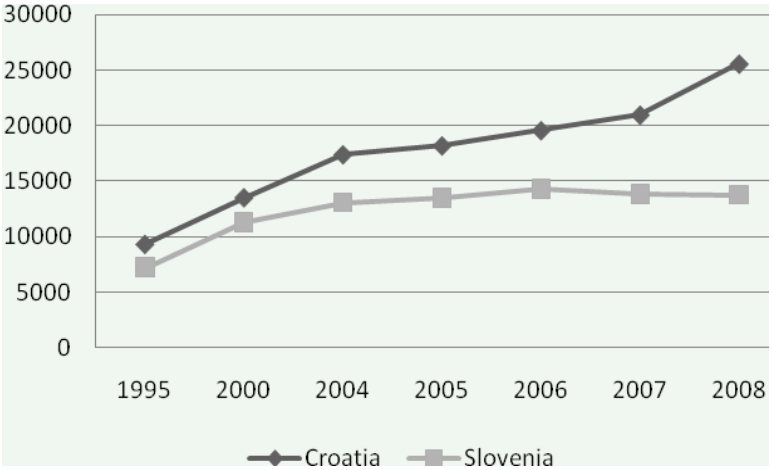


Note: * estimates
Source: Eurostat according to the European Commission (2009)

In both Croatia and Slovenia higher education institutions provide degree study programs established under the Bologna Declaration. In fact, the number of students admitted is restricted due to the limited number of places available in specific study programs. The tertiary education systems of both countries began functioning according to the Bologna Process in the 2005/2006 academic year. Flexible and dynamic tertiary institutions are major players when it comes to integrating their tertiary systems into the European Higher Education Area (EHEA) and the European Research Area (ERA) (MSES, 2007, 22). Resource problems have arisen during implementation so it remains to be seen if the Bologna Process can tackle both countries' chronic problems of high tertiary drop-out rates and long completion periods.

Countries that produce a high number of graduates per 1,000 young people (> 80) include Denmark, Lithuania and the UK. Slovenia performs close to the EU-27 average while Croatia produces relatively few graduates each year (< 40/1000 young people) like other countries such as Germany, Italy, Cyprus and Austria. The next figure (see Figure 2) presents tertiary education (ISCED 5 level) graduates in Croatia and Slovenia from 1995 to 2008.

Figure 2. Higher education graduates in Croatia and Slovenia



Sources: Statistical Yearbook 2009, Croatian Central Bureau of Statistics; Statistical Yearbook of the Republic of Slovenia 2009, SORS (2009)

It is evident that the number of graduates in Croatia has gone up significantly after 2006 when at the same time the equivalent figure has declined in Slovenia. In 2008 the median age of a student in Croatia was 20.8, namely lower than the EU-27 average (22.1), whereas the Slovenian median age was 22.2 (Eurostat, 2010a). The next part of the article explores the input and output variables of the Croatian and Slovenian tertiary system that are later used in our research analysis.

2.2. Tertiary education expenditure

As mentioned, the main inputs for the education system in Croatia and Slovenia are public expenditures. Public expenditures for higher education in Croatia are less than those in the EU-27 and Slovenia, which are nearly the same. Private spending on education in Croatia accounts for around 0.75% of GDP compared with ratios of around 0.4% in the EU-15 and EU-25. Despite the relatively high private spending on education there are very few private schools, although there is a growing number of private pre-school providers. School enrolment at the tertiary education level in Croatia is almost half that seen in Slovenia. Although the completion rates are low, in 2008 the number of tertiary education graduates in Croatia was higher than in Slovenia (see Table 1). While the number of graduates is rising, there is still a mismatch between skills demanded by the market and the skills produced by the education system (World Bank, 2008a, 104).

Table 1. Higher Education Indicators – Expenditure, Output and Outcomes in Croatia, Slovenia, EU-27 and OECD

	Total Public	Public Expenditure	School Enrolment	Graduates of Tertiary	Labor Force with

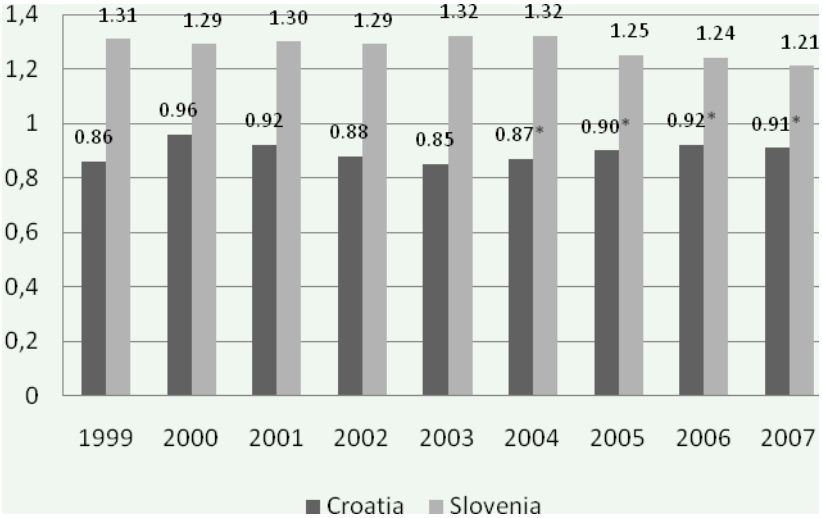
	Spending on Education in 2007 (% of GDP)	on Higher Education in 2007 (% of GDP)	Tertiary in 2007 (% gross)	Education (25 to 29) in 2008 (% of population)	a Tertiary Education in 2005 (% of total)
Croatia	4.1	0.8	44.1	20.7	18.2
Slovenia	5.2	1.0	88.0	20.1	21.0
EU-27	5.0	1.1	67.0	38.2	23.2*
OECD average	5.2	1.0	72.0	38.0	26.1*

Note: * Figure for 1999-2007 average.
Sources: Eurostat (2010b); OECD (2009a), OECD (2010), UNESCO (2010); World Bank (2010).

Overall public expenditure on education as a share of GDP in both countries is comparable with the EU average. Slovenian government expenditure on higher education has shown a positive trend in recent years, with nominal expenditures tending to increase faster than the inflation rate. The total amount of government expenditure rose by 5.9% in 2005 and 7.2% in 2006, while the amount of funds for educational purposes went up by 6.4% and 8.4%, respectively, in the same years (Tajnikar, Debevec, 2008, 290).

By contrast, expenditure at the higher education level in Croatia is far behind that in the EU and Slovenia (see Figure 3). The Croatian higher education system currently has too little by way of assured financial funds compared to European standards. The amount of outlays on tertiary education as a percentage of GDP in 2007 was 0.81%, namely, much lower than the EU average (1.3%).

Figure 3. Expenditure on higher education in Croatia and Slovenia (public expenditure as % of GDP), 1999-2007

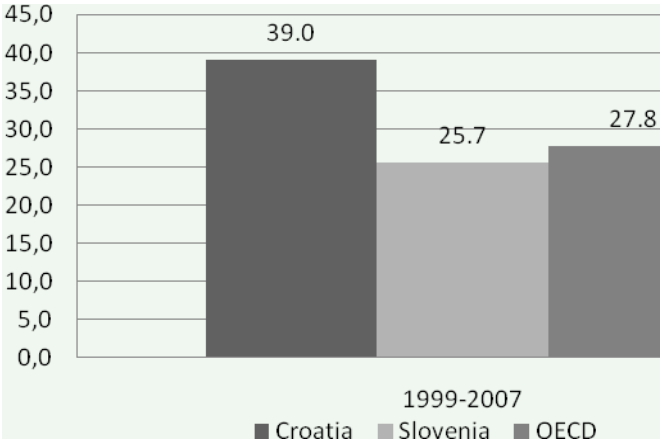


Note: * estimates; own calculations
Sources: Statistical Yearbook 2009, Croatian Central Bureau of Statistics; Statistical Yearbook of the Republic of Slovenia 2009, SORS (2009).

Then again, the data show that in the peak year of 2000 in Croatia public expenditure per student as a percentage of GDP per capita was almost twice the level in OECD countries (see Figure 4). Real per student spending on tertiary education dropped after that, although it is still higher than the average for the OECD and Slovenian comparators. The following figure sets out comparative figures for public expenditure per student in tertiary education for Croatia, Slovenia and OECD countries.

The main characteristics of Croatian education financing are: chronic under-funding, a lack of equity and transparency in budgetary allocation, an unbalanced structure of the education budget in terms of categories of expenditure and source of funds, and a lack of synergy (legislative, professional and institutional) for system change. The 4.1% of GDP share of total education expenditure in 2007 is well below the European average (5.0%), and the current level of funding is insufficient to support the reform process. Physical conditions vary widely from institution to institution, but facilities are often inadequate (OECD, 2001).

Figure 4. Public expenditure per student as a % of GDP per capita, tertiary (1999-2007 averages)



Source: UNESCO, 2010.

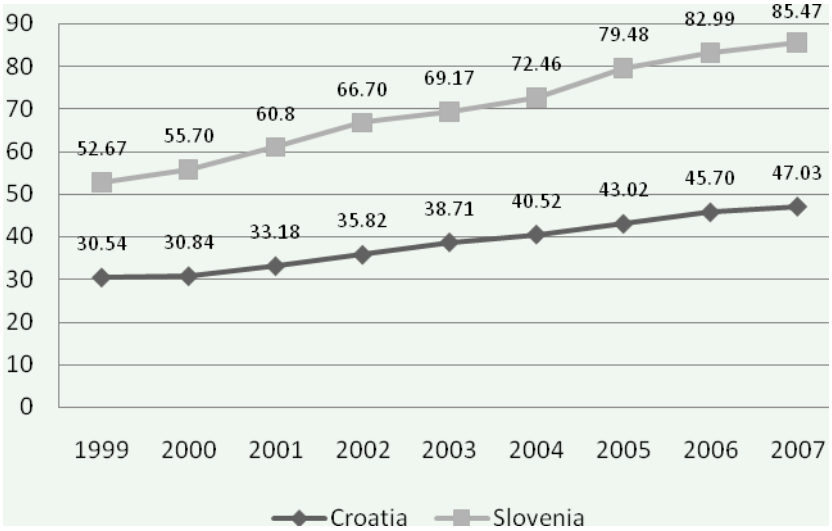
Conversely, the main objective of financing higher education institutions in Slovenia is to implement the goals of the national higher education program, along with respecting these institutions' autonomy in terms of the independent formulation of their institutional strategy and how they define the ways to achieve the set goals. The mechanisms of financing using public funds should enable higher education institutions to independently adopt decisions on expenditure and sustainable asset management. An important mechanism for ensuring the financial autonomy of higher education institutions is the integral (lump sum) financing of their academic activity. In the future, an internationally comparable share of GDP will have to be appropriated for the higher education and scientific and research activity of higher education institutions in Slovenia, meaning that the total funds allocated to higher education activity will have to rise (MHEST, 2010b). In this context, at least 1.3% of GDP from the budget and 0.3% of GDP from other sources is planned to be provided for tertiary education in Slovenia by 2015, and a total of 2.5% of GDP by 2020, of which 2.0% of GDP would come from the budget. At the same time, a new system of financing higher education would be introduced, consisting of a basic and a development pillar as of 2011.

2.3. Output/Outcomes

The basic assumption is that higher education systems are multi-product organizations which "produce" at least two different outputs – research and teaching – using multiple inputs. Generally accepted outputs of the higher education production process are the number of graduates of tertiary teaching as a proxy for teaching and the number of publications as a proxy for research (Warning, 2004, 396). In the last 10 years there has been a significant increase in the number of both enrolled students and graduates in Croatia compared to Slovenia (see Figure 5), along with the number of

student programs. In Croatia, almost three-quarters of young people who successfully complete secondary school commence tertiary education. These changes correlate with the enlargement and re-organization of HE institutions, primarily the establishment of polytechnics and schools of professional higher education (MSES, 2007, 72). In this way, gross enrolment rates for the tertiary level have been improving steadily over the past few years in Croatia, albeit they are still significantly lagging behind the figures for Slovenia. Gross enrolment at the tertiary level in Croatia was 47.01% in 2007 compared to 85.47% in Slovenia.

Figure 5. School enrolment, tertiary (% gross), in Croatia and Slovenia



Source: World Bank, 2010

Regarding outcomes in tertiary education, for example, although gross enrolment was about 46 percent in 2006 compared to around 53 percent in the EU-10 (Jafarov, Gunnarsson, 2008, 11), the proportion of graduates in Croatia is not high enough. Further, only one-third of students at the tertiary level reportedly complete their programs, with an average completion rate of 6.7 years for four-year programs (World Bank, 2008b). Non-completion rates in tertiary education were also very high, with the Ministry estimating that only one-third of all those enrolled were completing their courses of study. The serious internal inefficiencies at the tertiary level do not seem to have diminished in recent years (World Bank, 2008a, 114). The number of graduates in TE over the last 10 years has been rising constantly. A vast majority of students has finished their undergraduate programs (on average 92.3%), whereas 7.7% of students finished postgraduate studies (5.3% a Master of Science degree and 2.4% a doctoral degree). The average share of graduates in the natural sciences was only 4% and has been falling constantly since 1997 (from 4.9% to 2.9% in 2003) (MSES, 2007, 73).

A similar situation can be found in Slovenia where the majority of graduates come from the social sciences, business sciences and law, accounting for nearly one-half of graduates at the tertiary education level; as many as 70% of them were women. The smallest number of graduates was recorded in the fields of science, mathematics and computer science as well as agriculture and veterinary medicine – just 1,255 (slightly less than 7% of all) graduates. An observation over time of the trend in graduate numbers at the tertiary education level in Slovenia reveals that this number oscillated around 6,000 in the 1980s and at the start of the 1990s, and then started soaring after 1994. Twelve years ago it exceeded the 10,000 limit. By 2009 the number of all graduates had doubled compared to 1996 and even tripled compared to the period before 1990 (SORS, 2010).

The gross enrolment at the tertiary level in Croatia, although rising over the last few years, stood at 45.7% in 2006 compared to 53% in the EU-8 (World Bank, 2008a, 105). In 2007 it grew further to 47% compared to 86% in Slovenia and 63% in the EU-27 (also see Figure 5). Very little is devoted to capital investments. In the tertiary sub-sector, recurrent spending dominates by consuming 96% of the budget, with a distribution between wage and non-wage costs comparable to other countries but with just 3.9% for capital investment compared to an average of 11% among both the EU-15 and recent entrants (World Bank, 2008a, 111).

At the end of the transition period leading to the tertiary education level, when most young people have finished studying, access to employment is linked to the education level attained. Those who do not complete upper secondary education are much more likely to have difficulty finding employment when they enter the labor market. In contrast, tertiary education offers a premium for most job seekers, except in Greece, Italy and New Zealand (Obadić, Broz, 2008, 55). Education yields substantial returns to the individual in terms of earnings and employability and significant gains in economic growth and wider social benefits. Therefore, there is generally a positive relationship between educational attainment and the employment rate. In this way, those who have attained a tertiary education level have the lowest unemployment rates in the labor market. Table 3 shows the unemployment rate of those with a tertiary education from 1999 to 2007, also revealing they are much smaller for Croatia and Slovenia than in OECD countries.

Table 3. Unemployment with tertiary education (% of total unemployment)

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Croatia	11.3	13.5	9.1	10	9.5	9.8	9	9.7	11.8
Slovenia	7.0	4.3	5.3	3.4	3.2	8.2	8.6	11.5	12.5
OECD	13.4	13.1	12.9	13.3	15.8	15.2	15.4	15.1	14.9

Source: World Bank, 2010.

Another outcome of the higher education systems in Croatia and Slovenia is seen in the current world university rankings. Currently three worldwide university ranking initiatives are regularly published and subject to much public debate: the Academic Ranking of World Universities (ARWU)[5] from Shanghai's Jiao Tong University, the World University Ranking from the Times Higher Education (THE) and the "Webometrics Ranking of World Universities", although the most regularly published are the first two.

Table 4. Research and university rankings in Croatia and Slovenia in 2010

University	ARWU	Webometrics
University of Ljubljana (SLO)	401-500	151
University of Maribor (SLO)	-	534
University of Zagreb (CRO)	-	1,211
University of Rijeka CRO)	-	2,409
University of Zadar (CRO)	-	2,520
University of Primorska (SLO)	-	2,693
University of Nova Gorica (SLO)	-	3,295

Notes: "-" means not in the ranking
Sources: ARWU, 2010; THE, 2010; Webometrics, 2010.

In 2010, only the University of Ljubljana is listed in the ARWU ranking which ranks the top 500 world universities. "THE" ranking prepares a list of the world's top 200 universities and the list features not a single university from Croatia or Slovenia. The last ranking, Webometrics, creates lists for the world's leading 12,000 universities. On this list Slovenian universities perform much better than Croatian ones. Unfortunately, performance rankings based on publications and citations suffer from two shortcomings: first, research is not the sole purpose of a university so overall rankings should consider more than just publications; second, rankings based on publications and citations do not reflect efficiency (Warning, 2004, 396).

The total number of researchers has remained almost the same over the last 7 years, at around 7,000, making Croatia lag behind developed European countries regarding research work force. In order to assess how many people are actively involved in R&D and how important research jobs are in the labor market, it is necessary to calculate the number of full-time equivalent researchers (FTE) relative to the total number of people (headcount - HC) in the labor force. In the referent year 2003, Croatia reported 3.8 researchers per 1,000 labor force compared to 5.4 researchers in the European Union (EU25) and 3.5 researchers in the new EU Member States (EU10). With the exception of Slovenia, Estonia and Lithuania, Croatia has a larger pool of

[5] For more details about the different university rankings, see references: (ARWU, 2010), (THE, 2010) and (Webometrics, 2010).

researchers than the remaining EU10 countries (Švarc, Račić, 2007, 56). Research policy in Croatia is mainly generic in character, where support programmes for specific thematic areas are not very common in policy practice. However, it seems that Biomedicine science (biochemical engineering, molecular biology, medicine, pharmacy and related fields) has marginally higher priority, evident from the allocation for bio-medical research (Bojić, 2009, 21).

3. METHODOLOGY AND RESEARCH RESULTS

3.1. Methodology and Data

This research measures the relative (technical) efficiency of higher education in Croatia and Slovenia, as well as in comparison with other selected OECD and EU countries. Yet the characteristics of the higher education sector make it difficult to measure efficiency: it does not make a profit; there is an absence of output and input prices; and higher education institutions (HEIs) produce multiple outputs from multiple inputs (Johnes, 2006, 273). Therefore, a performance evaluation of higher education is based on multiple inputs and outputs and thus regressions based on only one output are unsuitable. To be precise, a non-parametric frontier analysis, namely data envelopment analysis (DEA), is the most recent methodology that is commonly used to examine the problems of measuring the performance of HE institutions (Athanassopoulos, Shale, 1997). Therefore, this research uses data envelopment analysis[6] as a methodological tool.

DEA is a non-statistical and non-parametric approach which makes no assumptions regarding the distribution of inefficiencies or the functional form of the production function (although it does impose some technical restrictions such as monotonicity and convexity). Instead, it uses the input and output data themselves to compute, employing linear programming methods, the production possibility frontier. The efficiency[7] of each unit is measured as the ratio of weighted output to weighted input, where the weights used are not assigned *a priori* but are calculated by the technique itself so as to reflect the unit at its most efficient *relative to* all others in the dataset. In a multi-output, multi-input production context, DEA provides

[6] DEA was developed by Charnes, Cooper, and Rhodes (1978) following work by Dantzig (1951) and Farrell (1957), and estimates a piece-wise linear production function relative to which the efficiency of each firm or decision-making unit (DMU) can be measured (Johnes, 2006, 275).

[7] Efficiency is defined as the relationship between inputs and outputs (outcomes), wherein monetary inputs are considered. Inputs (educational expenditure, students etc.) are "transformed" into outputs/outcomes (number of graduates, their knowledge etc.) through the "production" (pedagogic) process (Bevc, Uršič, 2008, 234).

estimates of the distance function which is a generalization of the single output production function (Johnes, 2006, 274).

In the first step, the frontier is drawn up by the efficient units. In the second step, hypothetical units are generated on the frontier to serve as reference units for inefficient higher education systems. These reference units are constructed as linear combinations of the most efficient units on the frontier. All inefficient units are enveloped by the frontier. On the basis of the empirical production function, in terms of best practice, DEA reveals those HE systems that are on the efficient frontier. It indicates the level of inefficiency of each system compared to the efficient systems[8].

The DEA method is essentially a linear program which can be expressed as follows:

$$\max h_k = \frac{\sum_{r=1}^{s} u_{rk} Yrk}{\sum_{i=1}^{m} v_{ik} Xik} \quad (1)$$

subject to

$$\frac{\sum_{r=1}^{s} u_{rk} Yrj}{\sum_{i=1}^{m} v_{ik} Xij} < 1;\ j = 1, \ldots, n. \quad \text{All } u_{rk} > 0, \quad v_{ik} > 0 \quad (2)$$

where *Y* is a vector of outputs; *X* a vector of inputs; *i* inputs (*m* inputs); *r* outputs (*s* outputs); *n* is the number of decision-making units (DMUs), or the unit of observation in a DEA study.

DEA fits a piecewise linear surface to rest on top of the observations. This is referred to as the "efficient frontier". The efficiency of each DMU is measured relative to all other DMUs, with the constraint that all DMUs lie on or below the efficient frontier. The linear programming technique identifies best-practice DMUs, or those that are on the frontier. All other DMUs are viewed as being inefficient relative to the frontier DMUs (Chapple, Locket, et al., 2005, 371). As already mentioned, the paper analyzes the relative efficiency of government spending on education in Croatia and Slovenia. It does so by comparing spending on these sectors and key higher education (outcome) indicators in the two countries. Relative efficiency is defined as the distance of a country's observed input-output combination from an efficiency frontier. This frontier is estimated using the DEA approach that was explained earlier and represents the maximum attainable outcome for a given input.

The data set in this research includes input data, i.e. expenditure per student, tertiary (% of GDP per capita), school enrolment (% gross), tertiary and

[8] Modified according to Warning (2004, 396).

output/outcome data, i.e. school enrolment, tertiary (% gross), labor force with a tertiary education (% of total) and the unemployed with a tertiary education (% of total unemployment) in a selected group of EU and OECD countries. In order to assess different inputs and outputs/outcome relative to technical efficiency, three models have been tested (see Table 5). The program used for calculating the technical efficiencies is the DEA*Frontier* software. The data are provided by Eurostat, the IMF, the OECD, UNESCO, and the World Bank's World Development Indicators database.

Table 5. Input and output/outcome set for the DEA

Model	Inputs	Outputs/Outcomes
1	○ Expenditure per student, tertiary (% of GDP per capita)	○ School enrolment, tertiary (% gross) ○ Labor force with a tertiary education (% of total) ○ Unemployed with a tertiary education (% of total unemployment)
2	○ Expenditure per student, tertiary (% of GDP per capita)	○ School enrolment, tertiary (% gross) ○ Labor force with a tertiary education (% of total)
3	○ School enrolment, tertiary (% gross)	○ Labor force with a tertiary education (% of total) ○ Unemployed with a tertiary education (% of total unemployment)

3.2. Results of Measuring Efficiency in Higher Education

When looking at the results[9], by using model 1 and applying the DEA efficiency frontier technique within a selected group of EU/OECD countries and Croatia to measure efficiency of higher education, Canada, Czech Republic, Finland, the Republic of Korea, Latvia, Lithuania, Poland, Russia, Slovakia and even Slovenia are seen as efficient. Here, the average expenditure per student, tertiary (% of GDP per capita) in the 1999-2007 period measures the input and as the output/outcome we use school enrolment, tertiary (% gross), labor force with a tertiary education (% of total, 1999-2007 averages) and the unemployed with a tertiary education (% of total unemployment, 1999-2007 averages). One can see that some countries come very close to the frontier (e.g. Hungary and Romania), while the other countries are further away and therefore less efficient (e.g. Cyprus and France) (see Table 6).

[9] All of the results relate to DEA with an output orientation, allowing for variable returns to scale (VRS). An output orientation focuses on the amount by which output quantities can be proportionally increased without changing the input quantities used. Using an input orientation approach leads to similar efficiency results as those presented in the text.

Table 6. The Relative Efficiency of Croatia, Slovenia and EU Member States/OECD Countries in Tertiary Education – Model 1 (Distribution by quartiles of the ranking of efficiency scores)

I. quartile	*II. quartile*	*III. quartile*	*IV. quartile*
Canada	Italy	Norway	Cyprus
Czech R.	Ireland	**Croatia**	Mexico
Finland	Austria	New Zealand	Denmark
Korea	Australia	Japan	France
Latvia	Bulgaria	Sweden	Netherlands
Lithuania	Romania	United Kingdom	Spain
Poland	Hungary	Estonia	Switzerland
Russia		Portugal	Iceland
Slovakia		Greece	Turkey
Slovenia			Belgium
United States			

Notes: Relative efficiency scores (Model 1) are based on expenditure per student, tertiary (% of GDP per capita, 1999-2007 averages) (as input) and school enrolment, tertiary (% gross), labor force with a tertiary education (% of total, 1999-2007 averages) and the unemployed with a tertiary education (% of total unemployment, 1999-2007 averages) (as output/outcome). Thirty-seven countries are included in the analysis (EU-27, OECD and Croatia).
Sources: World Bank, 2010; UNESCO, 2010; Eurostat, 2010a; OECD, 2010; own calculations

The results of the DEA analysis (model 1) also suggest a relatively high level of inefficiency in higher education in Croatia and, correspondingly, significant room to rationalize public spending without sacrificing, while also potentially improving, higher education outputs and outcomes (see Table 1). Indeed, Croatia is ranked in the third quartile and in terms of the efficiency scores for public spending, Croatia ranks in the 69th percentile among the 37 countries. With respect to individual output/outcome indicators, Croatia's ranking is in the last quartile for higher education school enrolment, the third quartile for labor force with a tertiary education and the second quartile for the unemployed with a tertiary education. In order to become an efficient country, Croatia should significantly reduce its average expenditures on higher education per student by around 10 percentage points (to around 29% of GDP per capita), to bring it near to the OECD average level (also see Figure 4).

Further empirical analysis, now focusing on model 2, suggests even worse relative efficiency results for Croatia. When using only two outputs/outcomes, Croatia's ranking is only 32 (out of 37). Similar to the results for model 1, in order to become efficient Croatia should cut its average expenditures on higher education per student by 6.3 percentage points. In terms of the efficiency scores, the efficiency benchmark is represented by Canada, Finland, the Republic of Korea and the USA. In contrast, some new EU member states lag well behind (e.g. Slovakia, Romania and the Czech Republic). Slovenia is ranked in 13th position and

would improve its efficiency score by significantly expanding its labor force with a tertiary education (by around 8.5 percentage points) (see Table 8).

Table 7. The relative efficiency of higher education (DEA test) in Croatia, Slovenia and selected EU/OECD countries

Model 1			
Country	***Output-Oriented VRS Efficiency***	***Rank***	***Benchmarks***
Canada	1.00000	1	Canada
Cyprus	1.18366	37	Lithuania, Slovakia
Czech R.	1.00000	1	Czech R.
Estonia	1.04146	21	Republic of Korea, Lithuania, Poland
Finland	1.00000	1	Finland
France	1.11527	34	Lithuania, Slovakia, Slovenia
Greece	1.02913	19	Finland, Republic of Korea, Lithuania, Slovenia
Hungary	1.00243	12	Lithuania, Slovakia, Slovenia
Ireland	1.02849	17	Lithuania, Slovakia, Slovenia
Italy	1.02854	18	Poland, Slovakia, Slovenia
Japan	1.05563	24	Lithuania, Russia, USA
Lithuania	1.00000	1	Lithuania
Poland	1.00000	1	Poland
Republic of Korea	1.00000	1	Republic of Korea
Romania	1.00460	13	Poland, Slovakia
Slovakia	1.00000	1	Slovakia
Spain	1.09684	32	Republic of Korea, Lithuania, Slovenia
Sweden	1.04480	23	Finland, Lithuania, Slovenia
United Kingdom	1.04353	22	Lithuania, Slovakia, Slovenia
USA	1.00000	1	USA
Croatia	*1.06280*	*26*	*Lithuania, Slovakia, Slovenia*
Slovenia	*1.00000*	*1*	*Slovenia*
Average	*1.08302*	*Lithuania, Slovakia, Slovenia*	

Note: Relative efficiency scores (model 1) are based on expenditure per student, tertiary (% of GDP per capita, 1999-2007 averages) (as input) and school enrolment, tertiary (% gross), labor force with a tertiary education (% of total, 1999-2007 averages) and the unemployed with a tertiary education (% of total unemployment, 1999-2007 averages) (as output/outcome). Thirty-seven countries are included in the analysis (EU-27, OECD and Croatia).

Sources: World Bank, 2010; UNESCO, 2010; Eurostat, 2010a; OECD, 2010; own calculations

Table 8. The relative efficiency of higher education (DEA test) in Croatia, Slovenia and selected EU/OECD countries (Model 2 and Model 3)

	Model 2		***Model 3***	
Country	***Output-Oriented VRS Efficiency***	***Rank***	***Output-Oriented VRS Efficiency***	***Rank***
Canada	1.00000	1	1.00000	1
Cyprus	1.67953	27	1.00000	1
Czech R.	2.22684	33	1.00150	7
Estonia	1.30988	16	1.05556	19
Finland	1.00000	1	1.05675	20
France	1.53264	24	1.12190	32
Greece	1.20181	10	1.11110	31
Hungary	1.68296	28	1.01490	9
Ireland	1.42107	21	1.03222	14
Italy	1.49834	23	1.05756	22
Japan	1.22651	11	1.10190	30
Lithuania	1.24196	12	1.00000	1
Poland	1.48874	22	1.03139	13
Republic of Korea	1.00000	1	1.23495	37
Romania	2.31993	35	1.01869	10
Slovakia	2.32826	36	1.00000	1
Spain	1.31759	17	1.14550	34
Sweden	1.16682	8	1.08518	27
United Kingdom	1.39209	19	1.05127	17
USA	1.00000	1	1.01436	8
Croatia	*2.21438*	*32*	*1.05913*	*23*
Slovenia	*1.25579*	*13*	*1.02909*	*12*
Average	*1.46587*		*1.0923*	

Note: Relative efficiency scores (model 2) are based on expenditure per student, tertiary (% of GDP per capita, 1999-2007 averages) (as input) and school enrolment, tertiary (% gross) and labor force with a tertiary education (% of total, 1999-2007 averages) (as output/outcome). Relative efficiency scores (model 3) are based on school enrolment, tertiary (% gross) (as input), labor force with a tertiary education (% of total, 1999-2007 averages) and the unemployed with a tertiary education (% of total unemployment, 1999-2007 averages) (as output/outcome). Thirty-seven countries are included in the analysis (EU-27, OECD and Croatia).

Sources: World Bank, 2010; UNESCO, 2010; Eurostat, 2010a; OECD, 2010; own calculations

Model 3 reveals that only three countries are technically efficient, i.e. Canada, Cyprus and Lithuania. With this model, Croatia once again lags behind Slovenia as far as relative efficiency is concerned. Indeed, in the group of 37 nations Croatia is only ranked in 23rd place in particular due to its relatively low rate of labor force with a tertiary education. By contrast, Slovenia has better efficiency results, despite it lagging behind the most efficient countries. The empirical results suggest that the Slovenian higher education system is inefficient due to its significantly high rate of school enrolment (in higher education) which is not leading to a higher rate of labor force with a tertiary education and a lower rate of the unemployed (with a higher education). Hence, the same output/outcome could be achieved with a much lower level of school enrolment (around 30 percentage points less).

According to our descriptive and empirical analysis, it is obvious that the higher education systems in Croatia and Slovenia suffer from relatively low technical efficiencies (in particular in Croatia). To improve each system's efficiency, performance-based funding models for higher education should be developed and further emphasis should be placed on quality assurance in higher education and the integration of the facilities. Moreover, curricula in universities should also be reformed to better reflect the needs of the economy, whereas dialogue and cooperation between the private sector and universities should be greatly increased. Indeed, trade unions and employers should be actively involved in education reform. That is especially important in the area of vocational higher education programmes in order to reduce labour market mismatches. Improvement of the education system should be a top priority of tripartitive dialogue.

4. CONCLUSION

Spending on higher education systems plays an important role in improving economic growth and development. At the same time, it represents an important tax burden on taxpayers. The efficiency with which inputs produce the desired outputs is thus an important public policy issue. In this study, an attempt was made to measure the relative efficiency of higher education across selected OECD and EU countries, in particular in Croatia (as an EU candidate country) and Slovenia, using data envelopment analysis (DEA) in a VRS framework. The research results suggest the significant inefficiency of higher education spending in Croatia and therefore the considerable potential to reduce government expenditure and/or to augment the higher education output/outcome. Conversely, regardless of the input-output/outcome mix, the higher education system in Slovenia is shown to have a much higher level of efficiency compared to Croatia as well as many other comparable EU and OECD countries. The results also indicate that some developed nations (e.g.

Canada, the USA) can serve as benchmarks for their efficient use of higher education resources.

Nevertheless, at least three caveats should be noted when we measure the efficiency of the higher education sector and they should be taken into consideration when interpreting the presented results. Firstly, the application of the presented techniques are hampered by a lack of suitable data to support those techniques. Quality data are needed because the techniques available to measure efficiency are sensitive to outliers and may be influenced by exogenous factors. Indeed, the substantial inefficiency found might simply be a reflection of environmental factors (such as climate, socio-economic background etc.). This also suggests the need to apply a combination of techniques to measure efficiency and effectiveness. Secondly, the precise definition used of inputs, outputs and outcomes might significantly influence the results. Finally, it seems important to bear in mind that, when using a non-parametric approach and despite DEA being an established and valid methodology, differences across countries are not statistically assessed, which may be considered a further limitation of such methodology.

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