Full Length Research Paper

Evaluating the efficiency of the higher education system in emerging economies: Empirical evidences from Chilean universities

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The objective of this study is to estimate the efficiency for a group of Chilean universities. Based on data envelopment analysis (DEA) technique, and taking into account the reality of the Chilean university system. A DEA model with two input variables [operating expenses and academics full time equivalent (FTE)] and three output variables (operating income, Institute for Scientific Information (ISI) publications and student enrollments) was developed to evaluate the performance of 34 Chilean universities. The empirical results indicate that 9 of each 34 institutions are efficient to financial performance level, and at the research and teaching levels. In addition, these do not reveal significant statistical differences, between the efficiency of public and private institutions.

Key words: Higher education, data envelopment analysis, emerging economies, Latin America, Chile.

INTRODUCTION

Currently some Latin American countries (for example, Brazil, Chile, Peru, etc.,) have shown a greater level of economic development, such is the case of Chile with a mean rate of GDP 5.3% of growth, registered in the last three years, according to the statistics of Chilean's government. This country is considered as one of the most important for foreign direct investment (FDI) in South America. It is very important to note that this fact is recent, since in the past decade. They do not have had this economic behavior. In this sense, is very interesting to study their education system. This is because many authors have argued (Peña-Vinces, 2009) that this (education) is one of pillar that allows to development of countries.

In the last times, the universities and the centers of researching came playing a very important role, in the competitiveness of countries, industries and companies, but particularly, in developed countries (Cho et al., 2007). These institutions act as a source of specialized knowledge that provide or help to build competitive international advantages for the firms that acquire them (Porter, 1998; Gualdrón and Dobón, 2010). At the same time, these help build clusters both local and regional by the abundance of new knowledge that these institutions develop and manage, thus enabling significant savings in corporate costs, specifically, in research and development activities (Peña-Vinces, 2009). In this sense, there exist many cases about it, one of them over

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Abbreviations: DEA, Data envelopment analysis; FTE, full time equivalent; FDI, foreign direct investment; DMU, decision making units.

North America in the music instrument manufacturers where the best professional of sector and the Scientifics work together. And another one more recognized is the Finland's case, in Europe in the sector of wood and biotechnology (Nilsson, 2006), or the Spain's case, where the 90% of the patents of the firms' biotechnology are developed thanks to the collaboration between universities and local research centers.

In Chile, 34% of people aged between 18 and 24 are students of higher education, which are equivalent to more than 768.000 students (MECH, 2009). The Chilean higher education system includes 209 both public and private institutions; mostly these are independent private institutions (88%), of which 61 are universities. Principally, universities offer programs level 5A and level 6, according to the International Standard Classification of Education (Brunner, 2008). The Chilean universities are primarily responsible for scientific and technological activity.

They directly generate over 87% of researching produced in Chile, in addition to international visibility. In Latin America, Chile ranks fourth in terms of volume of scientific articles ISI, and ranks first with respect to articles produced per each million of inhabitants (CRCHU 2008).

The political economy of the Chilean higher education system is clearly distinct to other Latin American countries (Brunner and Uribe, 2007). Brunner (2008) indicates that whether we considering the two main dimensions that characterize to the economic policy in favor of the higher education systems (relative proportion of enrollments in private institutions and relative proportion of expenditure from private sources), the Chilean higher education system places in the higher end of the "private" quadrant, next to Korea, Japan and Indonesia. In the systems of the "private " quadrant, as small-scale capitalist entrepreneurs, each institution competes for students, teachers and institutional prestige. Given this reality, economic efficiency standards set by the top managers of Chilean universities should be different from other Latin American standards.

An important difference between organizational control systems and technical control systems are finds in the presence of pre-determined standards. In the technical systems, such as electronic circuits and machines, there are pre-determined standards. In contrast, these last do not exist in organizational systems and they are the result of the actions of their managers (Anthony and Govindarajan, 2001). This is particularly the case of the service companies, as are universities.

Considering the above, is interesting to study the efficiency of Chilean universities as economic units within a highly competitive education system. The literature reviews show us, that there is no other study that has ever used data envelopment analysis (DEA) to measure

Chilean universities as business units. Therefore, the aim of this study is to evaluate the efficiency for a group of Chilean universities as business units, as mentioned previously, we used the DEA technique approach.

LITERATURE REVIEW

Data envelopment analysis (DEA) approach

Charnes et al. (1978) developed the DEA technique, based on Farrell (1957)'s work. This tool aims at assessing the efficiency of organizations or entities that these authors called "decision making units" (DMU). It has widely been used, in multiple studies as well as in Latin American studies (González-Araya and Verdugo, 2010; Rodriguez, 2003a; Rodriguez, 2003b; Silva and Ramírez, 2006).

DEA is a non-parametric approach of mathematical programming based on linear programming (Tzeremes and Halka, 2010) where the goal is determining the efficiency of a group of decision units that perform similar activities (Eken and Kale, 2011; Yang and Chen, 2010). This optimization approach indicates, the efficiency of a group of organizational units, using the envelope called "the efficiency frontier" (Charnes et al., 1978). It can provide data on the efficiency of each of the units under study, and categorize them according to the efficiency achieved in comparison with other units (Mcmillan and Datta, 1998; Yang and Liang, 2009), or their ratio reached in relation to rest.

The DEA analysis assumes that an organization in comparison with another is effective when this increases the quantity of products produced (outputs) and, it maintains a constant volume of the used resources (inputs) (Eken and Kale, 2011; Yang and Chen, 2010). Therefore, if an organization is able to maintain a constant amount of products obtained and decrease the amount of resources utilized, in this manner, it will be also more efficient (Díez Martín, 2008; Mcmillan and Datta, 1998; Yang and Liang, 2009).

Usually, a software that operates under a fractional model proposed by Charnes et al. (1978), known as constant returns to scale (CCR), is used to measure the efficiency in organizations (Martin, 2004).

The specification of model is one of the most important considerations for a successful DEA assessment. If a researcher uses an input variable as an output variable, or uses DMU heterogeneous, that is to say, with disparate activities, or excludes an important output variable or an important input variable in the model, the DEA analysis will produce, incorrect results, which are not consistent with the reality analyzed and could distort a plan based on the efficiency analysis (Diez de Castro, 2008; Yang and Liang, 2009).
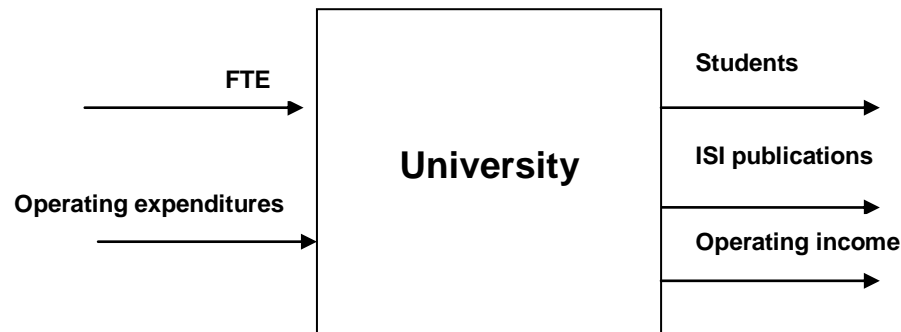
Figure 1. DEA proposed model.

Data envelopment analysis (DEA) and the higher education

Assessing the relative efficiency with DEA at universities is not a field of research recent. It has however increased considerably in recent years. Literature presents studies conducted in different countries, such as: Australia (Abbott and Doucouliagos, 2003), Chile (González-Araya and Verdugo, 2010), China (Ng and Li, 2000), Germany (Tzeremes and Halka, 2010), Portugal (McMillan and Datta, 1998), Spain (Martin, 2004), United Kingdom (Flegg et al., 2004) and United States (Colbert et al. 2000), and so forth.

Salerno (2003) in a comparative study, and with information coming different countries, has studied the efficiency of universities using the DEA approach. According to this author, a typical model DEA specifies two outputs, education and research, and two inputs, labor and non-labor. Student enrollment is utilized as indirect indicator of teaching; research grants or publications are used as indirect indicator of research. FTE academic staff is indirect indicator of labor and expenditure measures are indirect indicator of non-labor.

Our election for using DEA as technique for evaluating the efficiency of universities comes justified by Martin (2004), who affirms that the DEA is considered, sufficiently appropriate for use in measuring the efficiency of universities, since it can be adapted in accordance with the characteristics of the area to be analyzed.

Proposal data envelopment analysis (DEA) model

The DEA proposed model can be observed in Figure 1. It pretends to capture the results of universities on three key areas: profitability, research, and teaching. In this model, two input measures are specified: FTE academic as indirect indicator for labor, operating expenditures as result indirect indicator for non-labor. And the three output measures, as follows:

1) Student enrollments as indirect indicator result of teaching.
2) Number of ISI publications as indirect indicator of research.
3) Operating income as indirect indicator of profitability.

RESEARCH METHODS

Data and sample

Our empirical study is built on a list of the Chilean universities recognized by the Chilean government. The most recent data reported by the aforementioned institutions coming from the Chilean Ministry of Education were used (MECH, 2009). First, we excluded those institutions that they do not provide financial data relevant to the proposed model. Second, we excluded those institutions that do not record ISI publications during the year of analysis. Finally, immediately the data cleansing completed, our analysis was conducted with a sample of 34 institutions. All inputs and outputs of these universities are shown in Table 1. It is important to mention that the financial values are in millions of Chilean pesos.

The software

The software SPSS 15.0 and Frontier Analyst (version 3.04) were used to analysis. Frontier analyst was used on the output-oriented CCR model in order to obtain the DEA efficiency values (optimization mode "max out" and scaling mode constant). In accordance with this method, units are considered efficient when they register values or scores equal to 100.

RESULTS

Table 2 shows the Pearson correlation coefficients of all input and output variables, where it can be seen that they are correlated. It is important to highlight that they are all statistically significant. Only the correlation between student enrollments and operating expenses is less than 0.7 (0.683). However, this relationship has a Spearman Rho correlation equal to 0.835 (significant at 0.01

Table 1. The inputs and outputs of the data collected from the Chilean universities.

University	Type	Students	Operating income	Operating expenses	FTE	ISI publications
Pontificia U. Católica de Chile	PU	25420	381906	371538	1721	872
Pontificia U. Católica de Valparaíso	PU	14083	56630	52828	553	171
U. Adolfo Ibañez	FU	8801	37178	34486	182	31
U. Alberto Hurtado	PI	4546	11749	10844	176	10
U. Arturo Prat	PU	12359	28135	27882	424	29
U. Austral de Chile	PI	12434	48125	44496	762	280
U. Autónoma de Chile	PI	14889	31153	18005	477	4
U. Católica de la Santísima Concepción	PU	8960	18176	17382	322	34
U. Católica de Temuco	PU	6750	15565	14961	308	31
U. Católica del Maule	PU	6453	16113	15789	249	16
U. Católica del Norte	PU	11638	37540	37681	490	143
U. de Antofagasta	PU	7116	21047	21011	370	68
U. de Atacama	PU	3195	8303	7955	173	13
U. de Chile	PU	30997	228384	229131	1837	1124
U. de Concepción	PI	24092	159050	144668	1301	594
U. de la Frontera	PU	8388	35825	35537	368	151
U. de la Serena	PU	8269	20397	20370	314	55
U. de los Andes	FU	5976	24585	27092	411	37
U. de los Lagos	PU	13468	20100	19663	288	28
U. de Magallanes	PU	3830	11697	12257	260	42
U. de Playa Ancha de Cs. de la Ed.	PU	7859	15329	12975	390	6
U. de Santiago de Chile	PU	20851	63391	66133	917	256
U. de Talca	PU	8473	30240	28900	295	130
U. de Tarapacá	PU	8990	22053	19520	301	62
U. de Valparaíso	PU	17325	40560	35327	727	112
U. del Bío-Bío	PU	11808	25430	24681	440	67
U. del Desarrollo	FU	12480	42713	42235	358	26
U. Diego Portales	FU	13424	42132	37594	421	86
U. Mayor	PI	16206	51592	46317	105	10
U. Metropolitana de Cs. de la Ed.	PU	5528	13224	13653	293	16
U. Nacional Andrés Bello	PI	33330	99726	84689	1137	90
U. Santo Tomas	PI	23622	44407	41504	507	19
U. Técnica Federico Santa María	FU	15471	50389	47822	375	161
U. Tecnológica Metropolitana	PU	9370	19283	18773	333	14

FU, Foundation; PU, public corporation; PI, private corporation.

levels).

The average of CCR-efficiency scores of the sample was 87.17 (SD = 11.07). On the other hand, Table 3 presents the CCR-efficiency scores obtained from DEA analysis. Where it can see clearly that there are 9 out of 34 institutions which are CCR-efficient, such universities are Pontificia Universidad Católica de Valparaíso, Universidad Austral de Chile, Universidad Autónoma de Chile, Universidad de Chile, Universidad de Concepción, Universidad de los Lagos, Universidad de Talca, Universidad Mayor and Universidad Técnica Federico

Santa María.

Continuing with DEA analysis and taking into account, Figure 2 indicates the reference set frequency. The aim of it is to show how many times an efficient unit appears in comparison to an inefficient units' reference set. The higher the frequency, the more likely the efficient unit is an example of a good performance (Hussain and Jones, 2001). In our study, there are seven universities that have been referred by other universities: Universidad Autónoma de Chile (has been referred 25 times), Universidad Austral de Chile (has been referred 14

Table 2. The Pearson correlation coefficients for all inputs and outputs variables.

Input	Output		
	Students	ISI	Income
FTE	0.825(**)	0.908(**)	0.885(**)
Expenses	0.683(**)	0.899(**)	0.998(**)

**Correlation is significant at the 0.01 level (two-tailed).

Table 3. Efficiency results.

University	CCR-efficient
Pontificia U. Católica de Valparaíso	100
U. Austral de Chile	100
U. Autónoma de Chile	100
U. de Chile	100
U. de Concepción	100
U. de los Lagos	100
U. de Talca	100
U. Mayor	100
U. Técnica Federico Santa María	100
U. de Tarapacá	96
U. Santo Tomas	95
U. de la Frontera	94
U. Adolfo Ibañez	93
Pontificia U. Católica de Chile	93
U. Diego Portales	92
U. de Valparaíso	92
U. Católica del Norte	88
U. Nacional Andrés Bello	87
U. del Bío-Bío	87
U. de Santiago de Chile	87
U. de la Serena	84
U. Católica de la Santísima Concepción	84
U. del Desarrollo	81
U. de Antofagasta	80
U. Arturo Prat	77
U. Católica de Temuco	76
U. de Playa Ancha de Cs. de la Ed.	76
U. Alberto Hurtado	76
U. Tecnológica Metropolitana	75
U. de Magallanes	75
U. Católica del Maule	74
U. de Atacama	71
U. de los Andes	67
U. Metropolitana de Cs. de la Ed	64

times), Universidad de Concepción (has been referred 13 times), Universidad de Talca (has been referred 11 times), Universidad Mayor (has been referred 10 times), Universidad de los Lagos (has been referred 10 times) and Universidad Técnica Federico Santa María (has been referred 6 times). This means that, the relative
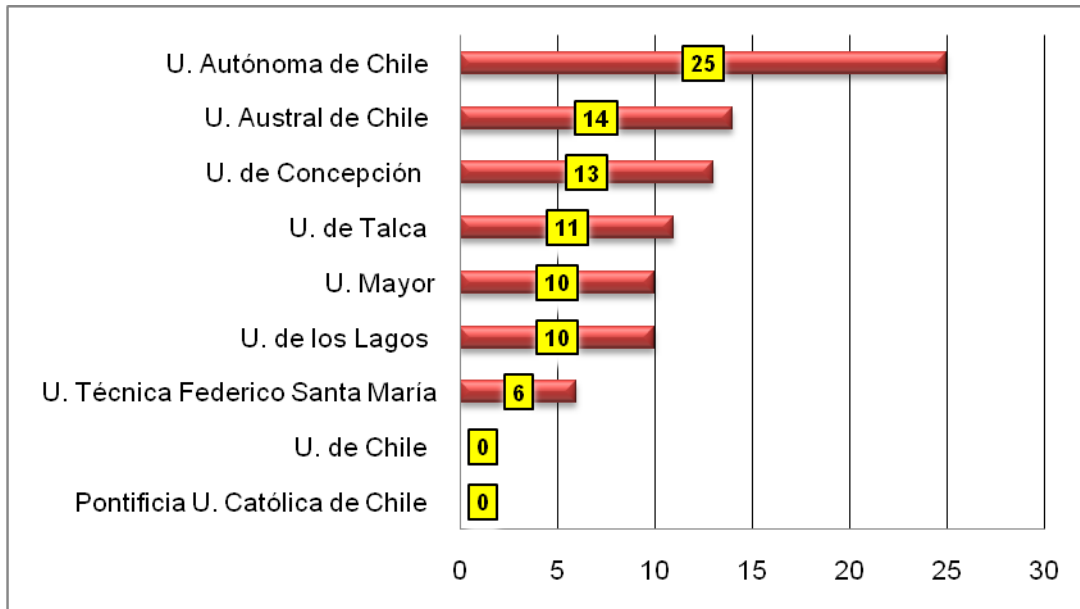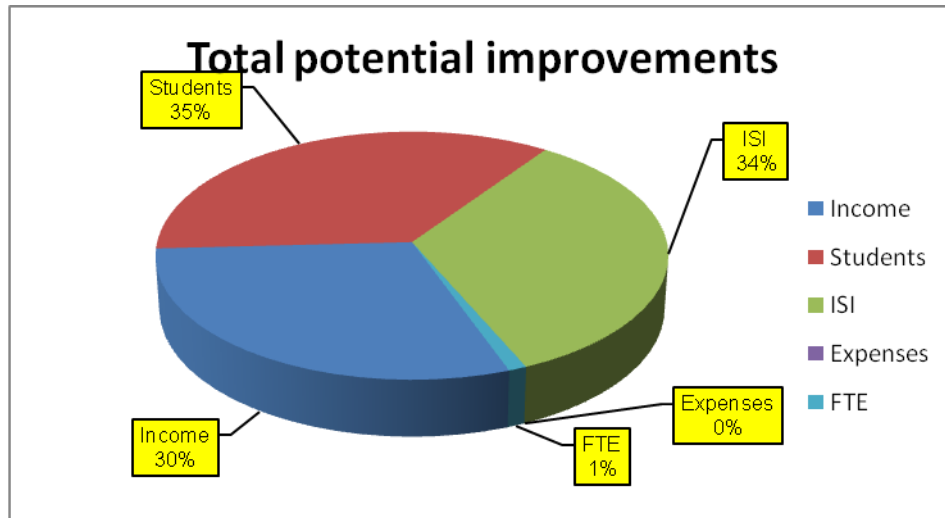
Figure 2. Frequency of reference set.

Figure 3. Improvement summary graph.

efficiency of these seven institutions is better than the other efficient or inefficient institutions.Once the reference set frequency analysis is finished, it will be necessary to observe the possible improvement of units or organizations here studied.

In this sense in Figure 3, we show the improvement summary graph. This graph indicates to us the student enrollment (35.48%), the ISI publications (33.74%) and operating income (29.74%). They will have similar potential improvements.

Efficiency of the public and private universities

To reveal differences between the efficiency of public and private institutions two analysis of variance (ANOVA) tests, were carried out. First, institutions were divided into three categories: public corporations, private corporations and foundations (Table 1). Therefore, our result indicate no significant statistical differences between the three categories ($F = 0.87$, $p = 0.429$). As the variables did not meet the requirement of normality and the sample sizes

in each group were very different, nonparametric techniques specifically Kruskal-Wallis test, was applied to corroborate T test results. The estimates provided similar results. Afterwards, institutions were divided into two categories: state run universities (N = 16) and non-state run universities (N = 18). Result indicates that, there are no significant statistical differences between the efficiency of state run universities and non-state run universities (F=1.31, p=0.229). As the variables did not meet the requirement of normality, nonparametric techniques specifically Mann-Whitney test, were applied to corroborate T test results. The estimates provided similar results.

DISCUSSION

This study has explored the efficiency of universities in a system of highly privatized higher education from a business analysis perspective. After proposing a model of efficiency that incorporates elements both subjective and non subjective (profitability), we assessed the relative efficiency of the Chilean higher education institutions with the DEA technique. The analyses of the results suggest that the top managers of Chilean universities hold established implicitly some business standards to evaluate and report their management. In addition, whether we accept the implications of sociological hypothesis of Chilean highly privatized higher education system, we must recognize that universities in the sample have achieved a remarkable efficiency. Furthermore, the uniformity of efficiency between public universities and the rest indicates us that all they are following the market rules.

The quality of services of the institutions of our sample has not been taken into account into the study. However, we believe that the quality is finding implicit in the economic performance of institution, due to, the fact that students accept the quality of service delivered with the price charged by it. In addition, while there are some elements of asymmetry of information between universities (suppliers) and students (customers), this might not explain the long-term economic performance of the institutions.

As shown the literature reviewed, universities are elements of great importance for the economics growth of countries. Therefore, the evaluation of their efficiency must be taken into account. Due to, policymakers, could encourage to some universities and neglect other. The problem in the system education is when they reward to ones less efficient (Universities). To sum up, our model could be serving as a new guide for the evaluation of the performance of the universities in Chile and other regions of Latin America with similar characteristics.

In last decades, the Chilean universities have experienced a drastic change. This is because to the traditional system has always been centered in the public education, in which only the best students would enter; however, the current higher education system is dominated by the private education which has made it to become a market highly competitive, in which universities should fight by keeping their share market in order to maintain its survival.

On the other hand, the qualitative information from Ministry of Education of Chile (Minduc, 2009) has revealed that, 85% of expenses in the higher education have a private character. In respect to the public universities, 75% of their income comes from student enrollment, of course not cheap when we compare it with developed countries like Canada, New Zeeland, or the United Kingdom.

As stated in the introduction, we need to continue to learn more about the different aspects of the Latin American universities, due to the lack of empirical studies from these countries. In this sense we propose a comparative study with another Latin American country, Peru; there universities are considered a business unit as well. Regarding to the limitations of this work, there are several that is to say, the cross-sectional character, and some model indicators were subjective; however, we believe that this work is a contribution to knowledge of reality to Chilean university system, and it will be useful to decision makers in universities, and in this manner it will foment public debate as well.

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