



## Factors Affecting the External Efficiency of Education in Iran (1972-2013)

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**Abstract:** *The educational external efficiency is viewed as the accountability of the educational system in various personal, social, economic and political aspects, which by understanding factors affecting the development of its status, it is clear that the reason for the non-fulfillment of the functions of education in a society is affected by qualitative and quantitative issues of education or lack of educational equity and institutional quality. Understanding the factors allows a country to be able to control most functions of education achieved without more abundant economic resources allocated to the educational system. This paper measures the efficiency of production process of education in Iran during 1972-2013 using a semi-parametric DEA input-based with constant returns to scale, and is able to identify surplus and shortage of inputs and outputs on inefficient units. Then, there are three steps to identify determinants of efficiency status. The first is a sensitivity analysis of efficiency in order to prioritize the inputs in efficiency, secondly, the separation process of the formation of the efficiency of external education into two sub-processes, in which first process efficiency (turning education into knowledge) is under internal efficiency of education and second process (turning knowledge into understanding) under the title of knowledge efficiency and thirdly, using time-series regression methods to examine the effects of "environmental factors" on the efficiency of external education. The results show that the external efficiency of education is achieved in 87% of the years studied. The high-output deficiency in order of importance in the external efficiency is related to production, environmental sustainability, productivity, stability and security of the family and the highest surplus is in expenditure on education and per capita teacher for per student. The major source of inefficiency is related to the second process, i.e, the process of transforming knowledge into understanding. Environmental factors of internal efficiency of education, knowledge efficiency, employment rate and economic independence, have a significant positive effect on the external efficiency of education and black economy (underground) volume has a significant negative effect on the external efficiency of environmental factors. Among studied environmental factors, the employment has the greatest impact on external efficiency of an education.*

**Keywords:** *Efficiency (internal and external), knowledge efficiency, DEA*

## INTRODUCTION

Development is a process requiring fundamental changes in the social, economic and cultural structure of a society indicating that the complex social system consistent with the diverse needs of basic desires of individuals in a society comes out of undesirable state and will lead to the optimal state. Education is one of the important pillars of human development which strengthens the two pillars of economic growth and health; thus, it is also the aim of developing education and development tools. However, in recent decades, despite the attention of many developing countries to train and a dramatic increase in quantitative indicators of education, such as years of schooling or share of education in GNP, achieving growth and development has not been realized and has lowered the economic growth in some countries. According to the United Nations during the years 1990-2013 -, despite constant training fee of GDP, as well as years of schooling, Iran continues its rapid growth creating a lot of concerns about sacrifice the quality of education against the quantity of education and educational equity. According to the statistics, despite the high growth of years of schooling in Iran, a steady trend of economic growth has been continued and yet Iran is involved in the poverty. Additionally, even though the level of welfare in Iran is negligible compared to countries with a high quality of life, there is no much difference in education indicators from those countries (UNDP 2014). Accordingly, the causes and sources of the external effectiveness of educational system in Iran make clear that the cause of slow economic growth and prosperity in the face of fast-moving education, are more affected by issues of quality and quantity of education or due to the lack of educational equity and institutional quality. Therefore, some strategies are presented for the systems which their more functions in the community are realized without allocation of more abundant economic resources to this system.

### 1. A review of the literature

#### 1-1-theoretical foundations

The ultimate purpose of education is to achieve an understanding (UNICEF, 2000). Understanding refers to the use of knowledge in all aspects of personal, social, economic and political life of educated individuals, which its effects spill down to the entire community (Monadie, 2010) and consequently, monetary and non-monetary benefits are defined for the education. Helping to make positive changes in the environment (economic, cultural, social), creating the institutions necessary for the meritocracy, reducing crime and delinquency, decreasing medical expenses and health, cultural autonomy and economic including the non-monetary interests of education and increased savings, investment in various types of capital (human, physical, social, natural), production, exports, employment, economic independence, technology and innovation, control population growth, total efficiency and a reduction in inflation, reducing waste and inefficiency of all financial and capital markets are viewed as the monetary benefits of education in stimulating economic growth and promoting quality of life.

External efficiency of education means an accountability of education system to the social system in various personal, social, economic and cultural aspects which in educational economic literature, the following three factors affect its desired state (Madandar 2011):

1- Share of education in the economy means that a few percent of the costs (or revenues) of macroeconomic (total public and private sectors) is engaged in the education sector, which logically distinct goals as the system's output, determine the amount of funding (input) that leads to the realization of these goals. 2. The internal efficiency (internal) shows the performance of the education system within the system. If the pass rate of students in each educational course and or the number of scientific documents taken at each level of education is determined according to the level of educational facilities, time education and education budget, the internal efficiency of the educational system is ascertained as well and several factors such as financial constraints and costs, equipment and technology, education, the teacher to student relationship, methods and contents of teaching, educational centers management, the incentive system of education in the family and society, educational level and parental income, influence on it. 3. Educational justice points to the fair distribution of educational facilities and the possibility of exploiting the spread of education and includes environmental factors. Although this concept is not normally considered as inputs or outputs of the educational system, it influences on its performance. Educational justice emphasizes on two points: first, the educational facilities are distributed in such a way that the possibility or chance to use them is provided for all members of society (class, age, gender, education, disciplines, and regions), which refers to justice during education. Secondly, even if all people have an equal chance in access to educational facilities, market conditions should also be a way that first: there was the opportunity to use the human capital implying that the unemployment problem is solved and secondly, there was a fairly opportunity to use this capital to all educated people according to the merit rules. These two important conditions are referred justice after education. Therefore, if the conditions of the labor market were in such a way that there was no possibility of using the human capital and equal and optimal exploitation through employment combined with meritocracy, efficiency and justice are distorted together and bottlenecks become more severe (Hawks, 2012). Factors such as education funding, income equality, institutions including those established and transferred institutions information between the educational system and the market, established institutions of property and contract rights and institutions are responsible for generating competition in markets including factors affecting educational equity.

## **1-2-Method**

In order to evaluate the efficiency of departments and systems and the impact of factors related to the performance of a unit with its effective factors, there is a function  $(v, u) f = Y$  in which inputs  $(v, u)$ , generate the output or  $Y$  and production function is a function that generates the maximum output for any combination of inputs, which there are two parametric and non-parametric methods for estimating it. For a system with multiple inputs and outputs, using non-parametric data envelop analysis or DEA is one of the suggestions.

DEA converts a multi-product production multi-mode factor of production into a simple multi-mode and single-product and uses linear programming and optimization techniques to determine the efficiency of each unit.

In order to increase efficiency targets for each of the units, a reference set is determined for an inefficient unit and compares efficiency of different units relative to efficiency border (Mehregan 2012, p. 54).

DEA method provides the following model to measure the efficiency of decision-makers:

$$\text{unit efficiency} = \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}}$$

Where:

$Y_{rj}$  = the output value of r from i unit

$U_r$  = weight assigned to output r

$X_{ij}$  = input value i am in j unit

$V_i$  = weight assigned to i input

S= number of outputs

m = number of inputs (page 58)

To find the maximum efficiency, the amount of fraction  $\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}}$  for all DMU should be maximized.

The above decision variables refer to the weight and solving the problem measures the most appropriate values for the weights of zero, and its efficiency.

The mathematical model is as follows:

According to the objective function, it is shown that this model is non-linear and convex and there is a problem that by its solving, a lot of infinite answer is obtained for  $u_r, v_i$ , therefore; fractional programming method and factor analysis are used to optimize the above model (Mehregan, 2012, p. 62). However, the nature of the model (input or output oriented) model productivity (increasing or decreasing or constant), the type of the model (basic or ranking) and the number of data (number of studied units  $3 \leq$  (number of inputs + outputs)) should be considered in the use of DEA (khajavi 2005, p. 77). Efficiency measurement using DEA method requires access to data in a very extensive period of time, if the inputs and outputs of a large system were not few. In some cases, these statistics may not be available, so principal component analysis and factor analysis are used to determine the most influential data and logical reduction of data volume. Principal component analysis is a method of multivariate data analysis that its main purpose is to reduce large

dimensions of studied problem. Principal component analysis can be used to replace a large number of explanatory variables (independent variables) that are associated with a limited number of new explanatory variables called principal components.

There are two ways to discover the sources of efficiency:

1. The separation of efficiency into technical efficiency and allocative efficiency
2. The separation of a complex production process into sub-processes and calculation the efficiency of each sub-process independently, implying that some of the intermediate products are input on the one hand and input of next sub-process on the other hand (Momeni 2011, p. 334).
3. Since for the conversion of education into recognition, there are two process for turning education into knowledge and vice versa (UNICEF, 2000), the second method is more suitable for resource discovery efficiency of the educational system.
4. Accordingly, the first stage efficiency (converting education into knowledge) can be measured as internal efficiency and second stage efficiency (turning knowledge into understanding ) is measured as a function of knowledge, to determine that in which of the following process, more weaknesses is observed.
5. To evaluate the effects of environmental factors on efficiency, several methods are used when the effect of environmental variables can be determined from low to high efficiency of units under study, such as Banker and Morey, CCR and Ferrier & Lovell for when environment variables are assumed continuous variables as well as two-step method to evaluate the efficiency scores correlated with environmental variables in regression equations and other methods of correlation analysis. Its benefits include the use of continuous and categorical variables and it can also measure the effects of various environmental variables at a specified interval on efficiency status and therefore; it lacks restrictions of other three methods. So we use two-step method in this study (Mehregan 2012).

### 1.3 Literature

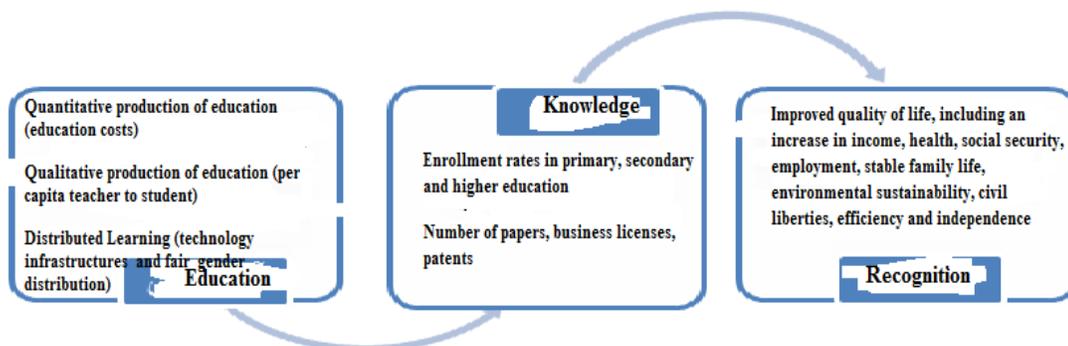
Aristovik (2013) analyzed the efficiency of education expenditure in Western Europe and OECD in 2011 using a two-step DEA. In the first step, he calculated weighted outputs (score from PISA) to inputs (percentage of education expenditures of GDP) and reached the conclusion that the internal efficiency of education in Japan, Korea, Finland in three primary school , secondary and university levels have been achieved and then by creating a regression equation between the efficiency scores and environmental factors affecting the efficiency found that the efficiency degree is heavily dependent on legal constraints and socio-economic backgrounds and even climate. By examining the efficiency of public spending of education in Europe and its impact on economic growth in Europe in 2004, Makelainen (2010) using econometric came to the conclusion that academic efficiency that has been measured by reducing crime and delinquency in proportion to the years of schooling, has been realized and the level of cognitive skills as measured by

reversing of crime and physical health in educated people, have a significant positive effect on economic growth and increased years of schooling does not have a positive effect on economic growth and significant as long as it does not lead to increased cognitive skills. By studying the efficiency of public spending of education in Europe and Japan in the period 1998- 2005 and the ratio of weighted outputs (academic rank in the world, ranking universities, publications, citations) into the weighted factors (number of participants in the education, science and technology parks activists, total education expenditures of GDP), Abine (2009) evaluated of the efficient education system and noted that environmental factors, including good quality of secondary education, transparent budgeting rules, independent auditors of educational institutions, school-based management can create significant positive effect on efficiency. By examining the status of education in 7 developed countries in 2003 and using data envelopment analysis DEA, Verhoon et al (2007) found that internal efficiency that is calculated from the weighted outputs (score evaluated by ideas, the rate of higher education graduates and secondary) to inputs (teacher quality, the level of government expenditure to GDP), is highly sensitive to the quality of teachers and increased education costs, have minimal effect in improving efficiency. In this study, America and Britain were absolutely efficient and France, Germany, Italy, Japan were in the next rank. To study the effectiveness of education (years of schooling) on the efficiency of Europe's economy, Doomench (2006) determined the efficiency of education using DEA method and calculation of output ratio (Global Index for Macroeconomic Competitiveness) into input. The results show that an increase of one percent in years of schooling has increased the effectiveness of macroeconomic data in Europe from 1.1 to 2.3 percent. By examining the efficiency of public spending on education in 140 developing countries during the years 1996-2002 and choosing of education expenditure inputs and teacher per capita to student and outputs of enrollment rates in primary and secondary schools, Herrera and Pang (2005) found that the countries dependent on international loans and oil revenues due to poor budgeting have lower education than other countries and these countries are able to increase 10 to 30 percent of their efficiency to inputs in education section. By evaluating the internal efficiency of secondary education in 25 countries, including OECD and several other countries in 2003 using DEA and several inputs for school time, per teacher to student and outputs for international mathematic score, Afonsoo (2005) found that in addition to exploring the situation and the degree of internal efficiency, environmental factors, including per capita income and parents' education level are factors affecting the internal efficiency of education. By examining the efficiency of education expenditures among the 24 countries using DEA in the period 2000- 2005 and by choosing inputs including government's cost in the education sector on the basis of purchasing power parity and literacy rate outputs, education of children up to fifth grade and the ratio of knowledge between female and male students in high school, Sabbagh Kermani (2009) found that academic efficiency has been enhanced during time and in the case of unrealized efficiency, lack of educational equity (lack of moderation in enrollment of different levels of education) have been one of the major sources of inefficiency.

## **2. Specification of the model**

### **2.1 Presentation of inputs and outputs**

To measure the efficiency, the production process must be firstly identified and appropriate inputs and outputs of each process are chosen based on the theoretical foundation. In the sub-process of transforming learning into knowledge, the education system tries to create knowledge outputs including enrollment rates at different levels of education (primary, secondary, tertiary), the number of educated people (or scientific degrees obtained), published scientific papers and registered patents by providing input, such as the percentage of education expenditures from GDP as the quantity of education, teacher per capita to student as the quality of education, enrollment ratio of girls to boys as justice through education and internet per capita per 1,000 people as technology infrastructure for education in the modern era (Hawks, 2012) (Janganie 2012). In the second process, the knowledge created in the previous step, provides the conditions for offering monetary and non-monetary benefits of education. These benefits can be influential on the quality of life, including financial excellence, health, security and stability, the stability of the family and society, sustainability and environmental protection, job security, political freedom and civil and independence freedoms (The Economist, 2005). In the original process, all the inputs of the first process create outputs for the second process. The following figure shows the process of the formation of intermediate products and final education based on the theoretical foundations of education economics.



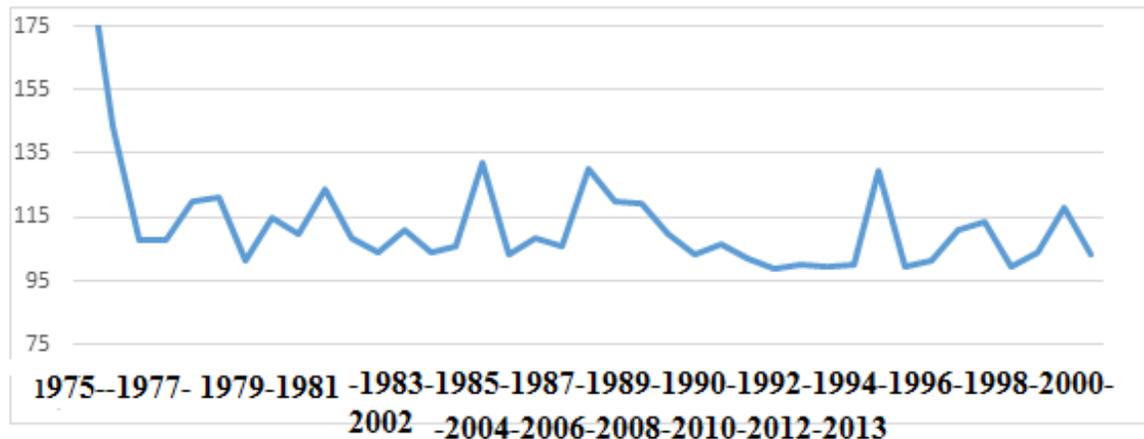
Since the inputs and outputs of the above-mentioned process are very numerous, the factor analysis - principal component analysis should be used to determine the most influential and reasonable reduction of data volume. According to the results of principal component analysis, four main process variables should be available to display inputs in the last analysis. With this analysis, only 7 essential variables were detected from 9 variables for the main process outputs. In addition, the outputs for the first sub-process were decreased from 6 to 5 variables. All inputs and outputs are used in research that is obtained after performing principal component analysis, shown in the following table:

**Table 1: Inputs and outputs**

The first sub- process (Transforming education (to knowledge)		The second sub- process (Transforming education to understanding)	
Output	Input	Output	Input
E3 (net enrollment rate (in higher education	E GDP (percentage of education (expenditures of GDP	GDP (gross domestic product per capita based on (purchasing power parity	E3 (net enrollment rate (in higher education
E2 (net enrollment rate (in secondary schools	Teach (per capita teacher for each (student	Life expectancy or life ) expectancy of the (population	E2 (net enrollment rate (in secondary schools
Paper (the number of scientific and technical (papers published	GDP (enrollment ratio of women to men in educational (centers	Formation and stability of ) families than the number of (marriages to divorces	Paper (the number of scientific and technical papers published
Patent (invention)	Population ( Internet per capita per 1,000 (people	CO2-1 (environmental or reverse ratio to CO2 released into the air per (person	Patent (invention)
trademarks		Productivity (productivity or the effective use of each of (the factors of production	trademarks
		Civil Liberties per capita ) for the number of newspapers or magazines (independent of government	
		Social Security or reverse ) capita crime of murder, (kidnapping and robbery	

**2.2 Measuring the external efficiency of education**

Based on the inputs and outputs in the previous step, the external efficiency of education (main process) is estimated by DEA and input-based approach and constant returns to scale, which is shown in the following diagram using ordinal AP method:



**Chart 1: external efficiency of education in years 1972-2013**

Accordingly, the external efficiency of education is achieved in 87% of the years studied. In the case of inefficient units, the maximum output is related to lack of productivity and the highest surplus is related to educational expenses.

**2.3 Sensitivity analysis of external efficiency of education**

For sensitivity analysis of a process for each input, the efficiency score is firstly calculated with all the inputs and then by removing one input, the efficiency scores will be calculated again and this operation is repeated for each input and finally, the amount of decreased value in each of these scenarios is compared. By removing the input, the average efficiency is greatly reduced and more units experience reduced efficiency or more units become inefficient, which is a very important in the in the education system (Appendix 4-4). The results of the sensitivity analysis are shown in Table 2.

**Table 2. Sensitivity analysis for system inputs**

Removing inputs	Average efficiency	The number of units that experienced reduced efficiency	The number of inefficient units
Without removing	1.13		5
TEACH P removing	1.09	21	9
E GDP removing	1.08	21	14
GPI removing	1.05	23	13

IT removing	1.04	31	14
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Source: Research’s calculations

In all four modes (i.e removing any of the four inputs), an average efficiency does not show a significant difference. This result means that the importance of four inputs in the development of the educational system is equal to the average scores of educational efficiency. But if the decision is based on the number of units that have experienced a decline in efficiency after removing any of the inputs or the number of units was inefficient, educational technology infrastructure, educational justice, education expenditures and the quality of education will be very paramount in the formation of efficiency status.

### 2.3 Resource discovery for External efficiency of education

According to the separation of complicated production processes into sub-processes and an independent calculation of efficiency of each sub- process, the source of efficiency in the first stage (converting education into knowledge) labeled as educational internal efficiency and second stage of efficiency (converting knowledge into recognition) labeled as knowledge function should be measured in order to determine that which of the following process has more weaknesses. The results of estimated efficiency in these two processes using DEA and input-based approach with constant returns to scale as well as AP method have been presented in the following.

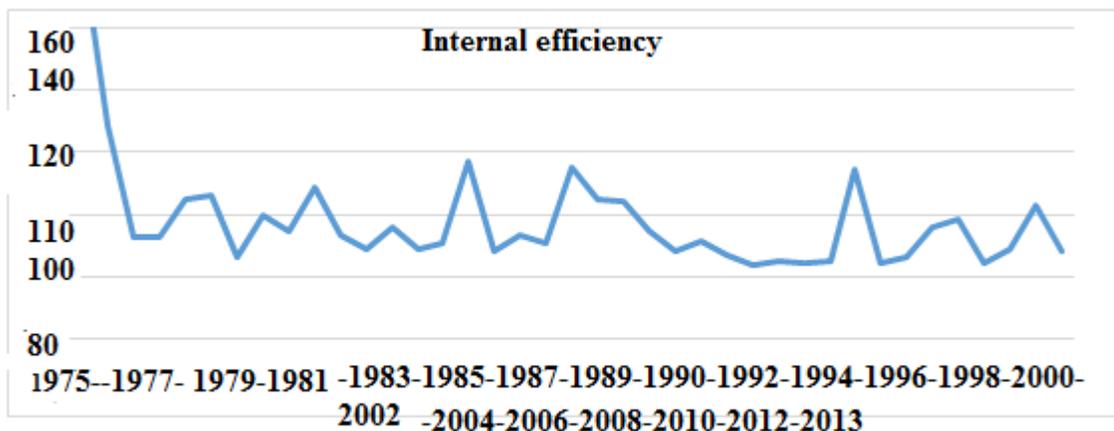
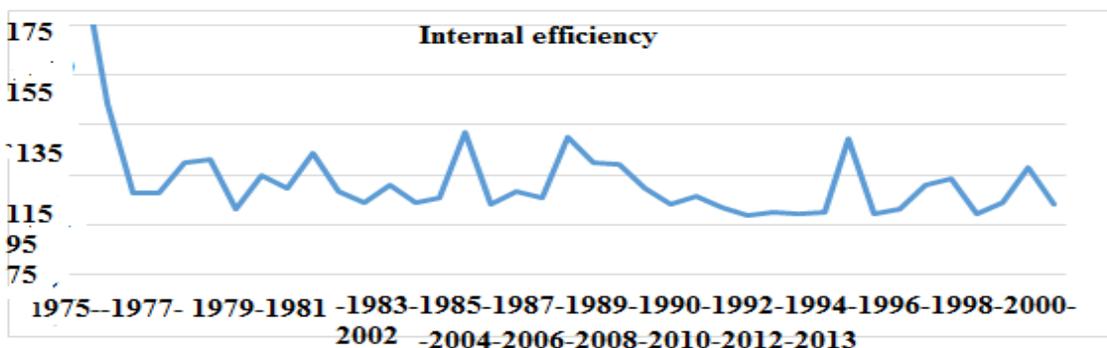


Chart 2: Internal efficiency of education

The internal efficiency of formal educational system has been achieved in 82 percent of the studied years and the internal efficiency of education on the inefficient units shows that the largest inputs’ surplus was

observed in per capita spending inputs on education and teacher per capita. Outputs for registered trademarks and patents have the greatest shortage.



**Chart 3: Knowledge efficiency**

In 51 percent of the studied years, knowledge efficiency has been realized. Knowledge efficiency about the inefficient units shows that the highest percentage of low output is related to the outputs of GDP, while the highest percentage is related to the largest inputs' *surplus* (about 27%) which is observed in the enrollment rate in higher education. The comparison of the educational internal efficiency (converting education into knowledge) and knowledge efficiency (turning knowledge into understanding) makes clear that the major source of inefficiency is related to the second stage of the process of turning knowledge into understanding. In other words, based on the definitions of management science, efficiency is more desirable than effectiveness.

**2-4. Studying the effect of environmental factors on the external efficiency of education**

Environmental factors are not considered to be inputs or outputs but severely affect efficiency. Studying the effect of environmental variables is carried out in two stages. In the first stage, the efficiency of process with normal inputs and outputs is solved (without the environment variables) and educational external efficiency scores are studied for all years studied. Then secondly, efficiency rating correlation with environmental variables is measured in the regression equations form. Thus, the dependent variable is educational external efficiency scores and environmental variables (independent variables) are presented on the basis of theoretical principles described in Table 4-7.

**Table 3: regression model variables for educational external efficiency and environmental education**

Variables	Descriptions	Source
Dependent: educational external	external efficiency scores	Research calculations

efficiency		
Independent: (environmental factors)		
educational internal efficiency	internal efficiency scores	Research calculations
Knowledge efficiency	Knowledge efficiency scores	Research calculations
Black economy	The difference between the calculated GDP by income technique and expenses (Alizadeh, 2011), explaining justice after education	World Bank 2014
Employment	The percentage of working population to the active population explaining justice after education	Research calculations
Independence	The growth rate of non-oil exports to imports, control variable	Research calculations

First, to avoid spurious regression, the reliability of variables is examined on the basis of augmented Dickey Fuller test. After assuring reliability,  $LFF=C+\alpha LFE+\beta KF + \gamma GBE + \delta LUM + \theta ES$  semi-logarithmic function is used to observe other classical assumptions in order to estimate more accurately the model. Then to ensure the results of model fit, heteroskedasticity, autocorrelation, normality of the error term are evaluated for the observance of the classical assumptions. Table 4-9 shows the results of the model.

**Table 4: Results of the estimated regression model for the external efficiency of education and environmental factors.**

Variable	Coefficients	T statistic	Probability
LFE	0.5	6.3	0.0000
GBE	-0.11	-0.8	0.4
LUM	0.67	3.4	0.004
ES	0.08	2.6	0.01
KF	0.03	2.2	0.04
$71=R^2$	$R^2$	D.W=2	

As can be seen, all variable coefficients are significant and consistent with the theoretical foundations except the coefficient for grounding black economy (GBE). The model has a relatively high explanatory power (62%) and based on DW statistic, autocorrelation signs are not observed. Therefore, educational internal efficiency, knowledge efficiency, employment rate and economic independence have positive and significant impact on the educational external efficiency and grounding black economy has a significant negative effect on educational external efficiency. Employment is the most effective factor for external efficiency because it can increase the efficiency of external education for all outputs in the production process.

### **Conclusion and Recommendations:**

1. Since in the calculation of external efficiency, the highest surplus input is in education spending, therefore, it is recommended that education spending should not be considered as action suggesting more attention to the education sector, but to avoid losses due to failure to pursue these resources and education costs. In addition, considering that the content of the discussions mostly move toward learning and cognitive skills including the twelve fundamental basic skills of life and their function, as well as sustainable development issues, special attention to issues related to family stability and sustainable development has seen progressive trend during the study periods, because of this, with more attention to sustainability output in families, other outputs such as productivity, production and security, which are deficient in some years, will be improved.
2. Given that educational internal efficiency about the inefficient units has the highest input surplus in educational expenditure inputs and the highest output deficit in registered trademarks and patents, it is recommended that a percentage of the national budget or the education sector to be spent for changing the direction of innovation system from linear and classic mode into comprehensive mode.
3. Given that knowledge efficiency about the inefficient units shows the highest percentage for output shortage related to GDP and the largest inputs' *surplus* (about 27%) in the enrollment rate in higher education, it is recommended firstly, more attention should be paid to the employment status of educated people, and even if the training of well-educated people is not in accordance with the technical requirements of the country, they should be screened in order to provide in-service training for them which has the greatest impact on improving labor productivity according to scientific studies. In addition to improving revenue growth and productivity, this process avoids incurring additional social costs of unemployment in the country. Secondly, training content offered in higher education should be reviewed and edited to fit the needs of demanders (market and society). Accordingly, the creation of a sector or unit of the Ministry of Higher Education at the Ministry of Industry and Mine (or agriculture and oil) eliminates the distance between the two institutions supplying education (higher education) and demanding of education (industry and mining, trade, agriculture, oil) and leads to the production of educational products tailored to the needs of demanders and an increase in employment and production. Thirdly, in the formal education system, care must be taken in the human capital

characteristics in a knowledge-based economy that is categorized in three main general aspects. In this regard, the general conditions necessary for success in the workplace as well as the employment skills should be firstly focused. Afterwards, occupational or professional standards, which is composed of the skills required in a particular industrial sector and the special and unique technical skills commensurate with the God-given resources available in each community should be paid more attention. Therefore, based on the abundant natural endowments in the country, the creation of disciplines related to the oil industry as well as paying particular attention to the potentials and God-given wealth and providing training and knowledge in the field of exploration, extraction, mining, transportation, and generally upstream and down manually oil industry not only create an employment opportunities for a lot of people but also provide benefits from an economies of scale and comparative advantages and in addition to the elimination of unemployment, which also resolves many social and economic problems, offer the underlying economic independence and enhance the efficiency of the an educational system.

4. The internal efficiency of the education system has been realized in 82% of years studied and knowledge efficiency 51% of the study period. Comparison of the effectiveness of internal efficiency of education and knowledge efficiency both in terms of average efficiency score and the number of functional units, make clear that the second stage of the process of turning knowledge into understanding is considered as a major source of inefficiency in the process of converting education into understanding. Hence, perhaps one of the most appropriate strategies is the implementation of strategies for empowering individuals. Because the results show the abilities that have been created but they have not been supported and the country is commonly expose to underdevelopment level. Thus, the government's strong support of talents and existing potentials and application of empowerment strategies and employment creation are proposed.
5. Given that environmental factors including educational internal efficiency, knowledge efficiency, employment rate and economic independence is a significant and positive effect on the external efficiency of education and the black economy has a negative effect. Employment is also recognized as the most effective external efficiency of education as well as job creation, which can provide economic independence leading to an additional positive effect on efficiency. Creation of reinforced institutions for productive activities against the non-productive activities (rent, bribery, embezzlement, smuggling, etc.) not only brings additional income and production, but also blocks the path to black economy, provides full economic recovery and increases external efficiency of education.

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