Measuring Education Inequalities: Concentration and Dispersion-Based Approach

-Lessons from Kuznets Curve in MENA Region-

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Abstract

Although the quantity of education is widely used to measure the economical and social performances of educative systems, only a few works have addressed the issue of equity in education. In this work, we have calculated two measures of inequality in education based on Barro and Lee's (2010) data: the Gini index of education and the standard deviation of schooling. The sample comprises 15 countries from the MENA region over the period 1950-2010. We used hierarchical clustering to control for the heterogeneity of the sample and identify the existence of cluster of similar value. We applied the Kuznets curve of education over the countries of the region. The findings show a decline in the Gini index within all the participating countries, for men and women and also for all age groups. The results also indicate that the education distribution was more unequal in the middle-income countries than in the higher-income countries in 2010, although they had almost the same level in 1970. The results suggested that the shape of the Kuznets curve depends basically on the measure used to approximate the inequality. Indeed, the Kuznets hypothesis is emphasized once we use the standard deviation of schooling. The Gini index, for its part, has maintained a significant negative relationship within the average number of years of the study.

Keywords: *Education inequality; Kuznets curve; MENA*

1. Introduction

Education plays a key role in the economic and social development processes of all countries. In fact, it helps to reduce poverty and to enhance the quality of social life. It is a basic ingredient within the strategies of improving health conditions. It also helps to decrease social, cultural and ethnic disparities among populations of the same country.

From an economic perspective, the level of education and its distribution within the population plays a crucial role in the prospects of income distribution and consequently in economic growth. Indeed, an increased level of education of a person leads to increased skills held by the workforce, which makes it possible to improve labor productivity and therefore economic growth (Barro and Lee, 1993, 1997; Barro and Sala-I-Martin, 1995; Aghion and Howitt, 1998).

Although the majority, if not all, of the countries of the world have been aware of the fundamental role that education may have in economic and social development processes, many of these countries are far from achieving mass education, including those in the MENA (Middle East and North Africa) region. The report of the World Bank (2007) notes that MENA countries have committed more resources to education than other developing countries at a similar level of per capita income. This shows that while progress has been made, some countries perform at a lower level than others' with a similar level of development. The Education For All report (2011) confirmed that in Arab countries, more than 6 million children were not enrolled in school in 2008, levels of learning achievement were low, more than one-quarter of the adult population was illiterate, and the learning needs of young children and adolescents

were continuing to suffer from widespread neglect. All these assessments were based on quantitative and qualitative indicators. Those indicators are not sufficient to understand the efficiency of the education system and neither are they an adequate way to measure its output and effectiveness. Over the past decade, many studies have accorded a huge importance to the possible role of equity in education in the development of countries. According to Thomas et al. (2001), access to education is hugely unequal in several countries.

If education is not equally distributed among the population, a large part of the revenue will be owned by a well-educated minority, which engenders huge inequalities in the distribution of incomes which causes more poverty (Glomm and Ravikumar, 1992; Lopez et al., 2002). To our knowledge, no work has been done to assess the performance of education systems in the MENA region by considering the distribution and inequality of education.

This paper aims to elaborate on the measure of education inequality in the MENA region and then to test the validity of the Kuznets curve hypothesis in the field of education. The second section of this paper will deal with the literature review about the measurements of education inequalities. The third section develops the Gini index of education and discusses the results of our calculations in the MENA region. The fourth section will test the Kuznets hypothesis in education. The last section is a conclusion.

2. The measurement of educational inequality: definition and literature review

Even though the educational quantity is measured by the enrollment ratios, and average years of schooling has been the approximation mainly used for the growth regressions (Barro, 1991, 1993, 1997; Mankiw, Romer, and Weil, 1992; Thomas et al., 2000), some studies support an alternative measurement that takes into consideration the inequalities in education. In this respect, the Gini index of education, which was developed by the statistician Corrado Gini, is the most commonly used measure. It was first used in the field of economics to describe household income inequality.

The Gini coefficient for education goes back to the 70s with the previous works of Ter Weele (1975), Rosthal (1978), Maas and Criel (1982) and Sheret (1982, 1988). In the same context, Maas and Criel's (1982) contribution is considered to be the first fully expressed attempt to allow the Gini coefficient to be calculated to measure educational inequalities. As a fact of matter, their work mainly focused on this coefficient on schooling data of 15 countries. Thomas, Wang and Fan (2002) defined the Gini coefficient as the weighted sum of absolute differences of education levels of a population. They applied this coefficient to 140 countries from 1960 to 2000, and the attained results demonstrated a drop in the level of educational inequalities for most of the countries of the world, but with a significant improvement for some countries such as South Korea, Tunisia and China, in contrast to countries like Mali and Afghanistan where the Gini index of education showed an unequal distribution of about 0.9. Zhand and Li. (2002) examined the international inequalities and the convergence of educational levels from 1960 to 1990. They showed that the difference in schooling level between the developed and the developing countries on the one hand, and between men and women on the other, was still increasing during the same period. However, as many studies have maintained, the schooling level dispersion, as measured by the coefficient of variation and the Gini coefficient, declined during this period irrespective of gender or the countries' stages of development. Qian and Smyth (2008) considered a measure of the educational inequality between the coastal and inland provinces of China. They compared it to the urban-rural educational inequality by using the Gini index of education. The findings strongly suggested that the major cause behind the educational inequality in China resulted from the access to schooling disparity between the rural and urban areas in 2000. Sahn and Younger (2007) agreed with the notion that Sen (1979, 1987) promoted. The latter confirms that income is not a sufficient measurement for welfare. In fact, both health care and education may constitute the intrinsic aspects that determine individual welfare. Thomas et al. (2002), meanwhile, used the results of the tests carried out by TIMSS in 1999 (38 countries) and in 2003 (49 countries). In the same order, Sahn and Younger used an alternative index named "Generalized entropy". The results show that more than half of the total inequality are due to intra-country differences. In a recent study, Morrison and Murtin (2010) calculated the global inequalities of education and incomes from 1870 to 2000 via an estimation of human capital distribution since 1870. They suggested that education inequality was quit large in the 1870s. The Gini coefficient reached 0.79. In 1870, 75% of the world population were illiterate. In 2000, the situation improved significantly so that the Gini index reached almost half of what it measured in 1870. This rapid decline refers basically back to the increase in the literacy rate which became 88% in 2000 compared to 15% in 1870.

3. The measure of inequality in education in MENA region

We relied on Thomas et al.'s (2002) formula to measure education inequality in the MENA region in order to construct the Gini index of education. This index considers the distribution of schooling years amongst the population:

$$Egini = \frac{1}{\mu}\sum_{i=2}^{n}\sum_{j=1}^{i=1} P_i \langle Y_i - Y_j \rangle P_j \quad (1)$$

$$SDS = \sqrt{\sum_{i=1}^{n} p_i (y_i - (\sum_{i=1}^{n} p_i y_i))^2} \quad (2)$$

With the *Egini* index of education, which depends on schooling level, μ is the average number of schooling years of the population, Pi and Pj represent the part of the population having i and j schooling levels, Yi and Yj are the accumulation of the school years according to each level of education, and n is the number of school levels. The classification of Barro and Lee (2010) identifies seven levels of schooling. SDS is the standard deviation distribution of schooling. In this paper, we have assumed that the duration of each level Y1 remains constant throughout the entire period and is identical for all the countries.

3.1 A steady decline in educational inequality

Table 1 shows the evolution of the Gini index in 15 countries of the MENA region (distributed according to income level) in the period between 1970 and 2010. In fact, in 1970, the countries of the MENA region recorded very high indices in educational inequalities. For all the middle-income countries, the inequalities in education were very strong: for example, Morocco (0.90), Egypt (0.88) and Iraq (0.87). After that, in 2010, the situation clearly improved among all the countries of the MENA region. This is broadly in line with the outcomes of Thomas et al. (2002). The lowest values are seen in high-income countries. However, the decline rates of the Gini index of education vary from one country to another. Indeed, in countries like the United Arab Emirates, Bahrain, Egypt, Jordan and Algeria, the Gini index declined by at least 45% in the period between 1970 and 2010. However, for other countries like Morocco, the inequalities declined slowly within the same period.

The remarkable divergences between the countries of the MENA reflect the divergence of efficiency of efforts devoted by each country to reducing inequalities of access to different levels of education.

Table 1: Gini coefficient of education in the MENA, selected countries, 1970-2010

Country		1970	1975	1980	1985	1990	1995	2000	2005	2010
Middle-income countries	Jordan	0.68	0.64	0.59	0.53	0.46	0.41	0.36	0.33	0.3
	Turkey	0.66	0.6	0.55	0.5	0.46	0.41	0.35	0.31	0.3
	Iran	0.82	0.77	0.7	0.63	0.57	0.52	0.45	0.4	0.36
	Syria	0.71	0.66	0.6	0.53	0.48	0.43	0.42	0.39	0.37
	Algeria	0.82	0.76	0.7	0.63	0.56	0.5	0.45	0.41	0.38
	Tunisia	0.82	0.75	0.67	0.65	0.6	0.54	0.49	0.45	0.41
	Egypt	0.88	0.84	0.76	0.66	0.61	0.56	0.5	0.46	0.42
	Iraq	0.87	0.83	0.77	0.69	0.62	0.57	0.53	0.52	0.49
	Morocco	0.9	0.87	0.83	0.79	0.74	0.69	0.65	0.61	0.56
High-income countries	Bahrain	0.71	0.63	0.56	0.51	0.45	0.33	0.25	0.22	0.2
	United Arab Emirates	0.8	0.76	0.71	0.66	0.59	0.5	0.41	0.33	0.28
	Saudi Arabia	0.69	0.65	0.6	0.54	0.48	0.46	0.41	0.36	0.3
	Kuwait	0.62	0.68	0.61	0.55	0.52	0.5	0.44	0.36	0.33
	Libya	0.76	0.7	0.65	0.6	0.53	0.48	0.45	0.42	0.4
	Qatar	0.71	0.67	0.63	0.59	0.57	0.52	0.49	0.45	0.42

Source: Author's realization

As can be deduced from the table, Morocco is the country where the inequalities in education are most pronounced compared with the sample of this study. This outcome is easily understood when we take into consideration the fact that in Morocco we can find the highest illiteracy rates and the lowest average number of schooling years of the sample.

Our results confirm those of Thomas et al. (2001), that even if the countries of the MENA region managed to reduce the Gini index of education between 1960 and 2000, they were still far from the performances achieved by countries in other regions of the world, especially those of East Asia and Latin America.

The Figure 1 shows that the Gini index and illiteracy rates are positively correlated for the whole sample. This outcome has strong implications in terms of education policy. This means that the literacy of individuals should be a priority in order to improve the distribution of education within a country and consequently increase the number of schooling years of its people.

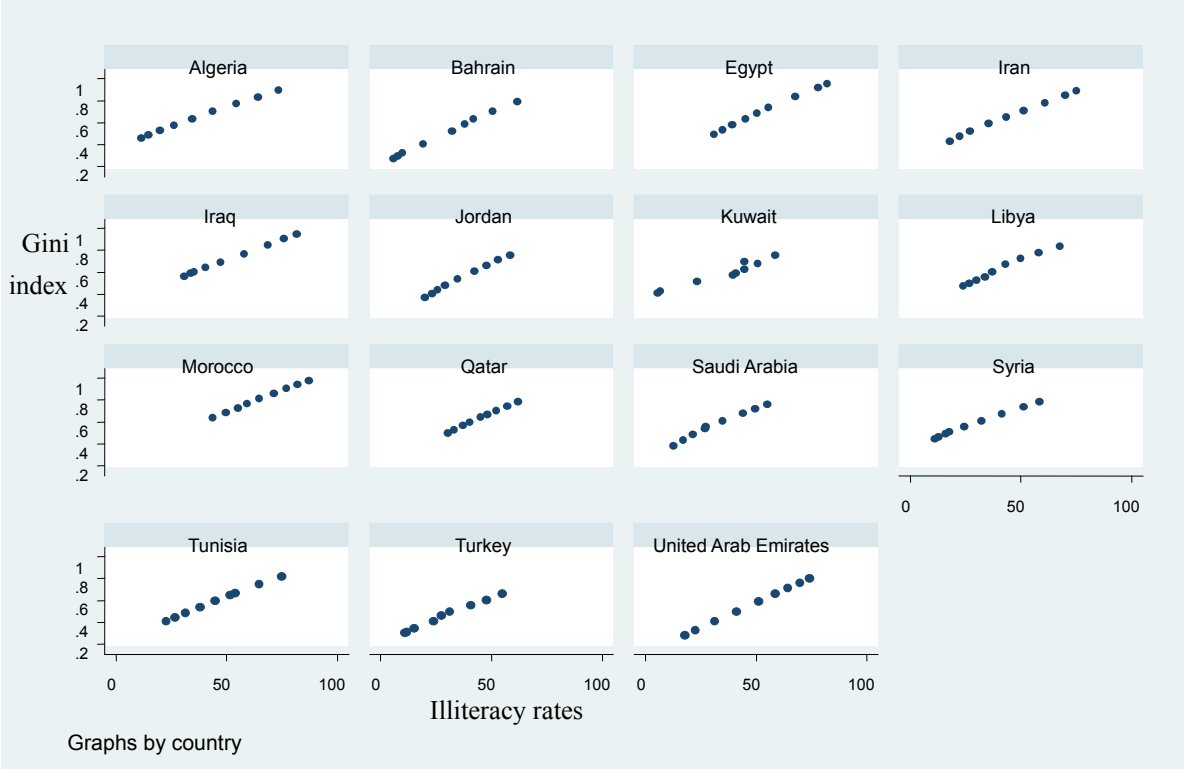


Figure 1: Gini index and illiteracy rates, 1970 -2010

To better understand the evolutionary process that educational inequality undergoes, and possibly record the divergences between countries, we have proceeded through a hierarchical classification (see Box 1) of countries according to two measures corresponding to the educational inequality in 1960 and 2010. We have also tried to check the hypothesis regarding which of the high-income countries are more efficient than the low-income countries in terms of reducing the inequalities. The obtained dendrogram for 1960 allows us to identify two types of groups. The first comprises eight countries: Algeria, Egypt, Iran, Iraq, Libya, Morocco, Syria and Tunisia (middle-income countries except for Libya). The second consists of seven countries: Bahrain, Jordan, Kuwait, Qatar, Saudi Arabia, Turkey and the United Arab Emirates (high-income countries apart from Turkey and Jordan). The results, on the one hand, clearly show that both groups have higher values on the Gini index (Group 1 with 0.89 and 0.7 for group 2). But on the other hand, the distribution of educational attainment, as measured by the standard deviation, is lower in group 1 (23.59) than in group 2 (40). As far as the F-test of ANOVA table is concerned, the stated difference between the two groups is significant at 1%.

Table 2: Hierarchical classification of the Gini index and the standard deviation of schooling by the level of income in the MENA countries, 1960

Country	Groups	
	1	2
Algeria	1	0
Bahrain	0	1
Egypt	1	0
Iran (Islamic Republic of)	1	0
Iraq	1	0
Jordan	0	1
Kuwait	0	1
Libyan Arab Jamahiriya	1	0
Morocco	1	0
Qatar	0	1
Saudi Arabia	0	1
Syrian Arab Republic	1	0
Tunisia	1	0
Turkey	0	1
United Arab Emirates	0	1
Total	8	7

Source: Author's realization

Applying the same work as above to the year 2010, the dendrogram acknowledges a split of the first sample into two groups. Group 1 is composed of 10 countries of which three are in the high-income range: Algeria, Egypt, Iran, Iraq, Jordan, Libya, Morocco, Qatar, Tunisia and the United Arab Emirates. The second group is composed of five countries of which two are in the middle-income range: Bahrain, Kuwait, Saudi Arabia, Syria and Turkey. Compared to 1960, it is noticed that the Gini index undergoes a much bigger decline for group 1 than for group 2, with values of 0.4 and 0،3 respectively.

If it happens that the countries of group 1 have decreased the Gini index range, the schooling distribution as measured by the standard deviation will be merely doubled from 23.59 in 1960 to 53.11 in 2010, but it stays almost stable for group 2.

Table 3: Hierarchical classification of the Gini index and the standard deviation of schooling by the level of income in the MENA countries, 2010

Country	Groups	
	1	2
Algeria	1	0
Bahrain	0	1
Egypt	1	0
Iran (Islamic Republic of)	1	0
Iraq	1	0
Jordan	1	0
Kuwait	0	1
Libyan Arab Jamahiriya	1	0
Morocco	1	0
Qatar	1	0
Saudi Arabia	0	1
Syrian Arab Republic	0	1
Tunisia	1	0
Turkey	0	1
United Arab Emirates	1	0
Total	10	5

Source: Author's realization

This analysis reveals that Syria is the only country that has "migrated" from the less efficient group 1 to the

more efficient group 2. Paradoxically, countries like the Emirates, Qatar and Jordan have "migrated" to the less efficient class. This may be explained by the fact that although these countries have come to lower the Gini index, the schooling dispersion remains high. The process of "migration" of countries between the groups is demonstrated in Table 4.

Table 4: The process of "migration" between groups in 1960 and 2010

		Average Linkage (Between Groups)		Total
		1	2	
High-income countries	0	7	2	9
	1	1	5	6
Total		8	7	15

Source: Authors' realization

3.2 The persistent of educational inequalities between gender

We have calculated, at the same time, the Gini coefficients of education based on gender. By doing this, it proves that the inequalities in education were generally reduced for both sexes and over all the countries between 1970 and 2010. Despite this general tendency, the level of inequality in education among women was still obviously higher in 2010 for some middle-income MENA countries (Morocco (0.64) and Iraq (0.56)). This reflects the discrimination affecting women in the schooling process.

The countries that managed to reduce the inequality in education significantly were Bahrain and the Emirates (higher-income countries) with 0.22 and 0.28 respectively. Meanwhile, the other countries show intermediate values of the Gini index between 0.3 and 0.5.

It has been revealed that the education policies in the MENA region neglected female schooling. For some countries (especially higher-income countries), the distribution of access to school for men was more unequal than for women at certain times: Kuwait (1985, 1990 and 2010); Libya (2005, 2010); Qatar (from 1980 to 2010) and the United Arab Emirates (from 1985 until 2010).

By analyzing the difference of the Gini index between men and women, it has been shown that Morocco was the only country where the gap continued to increase. It doubled between 1970 and 2005 from 0.08 to 0.17 respectively before declining by one degree but eventually stabilizing at 0.16. This gap continued to narrow in some countries like Jordan, Libya, Syria and Turkey in the period between 1970 and 2010. However, for other countries the gap between the two indices continued to rise until the period 1985-1990. After that, it started to fall between the years 1990 and 1995.

We have analyzed the evolution of the inequalities according to sex by the use of hierarchical classification method techniques. The results are shown in Figures 2 and 3.

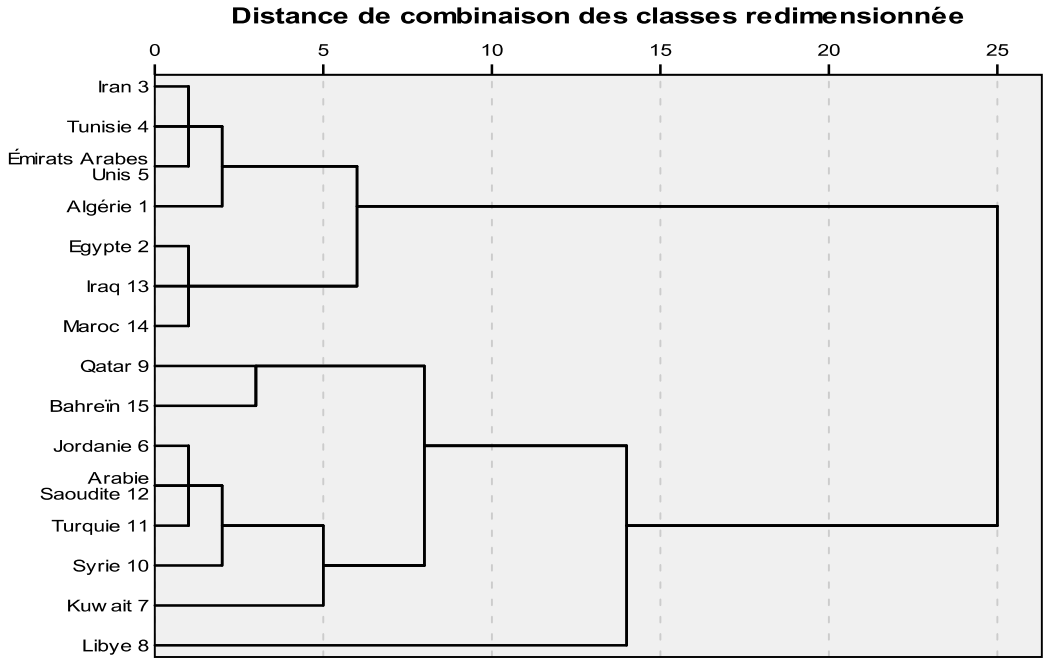


Figure 2: Classification of the MENA countries in 1970 by sex dendrogram

In 1970, Morocco belonged to the group where inequalities deeply affected both men and women (the average of the Gini index in this group is 0.9 for women and 0.78 for men). Libya alone was positioned in an intermediate situation. The most efficient group for both sexes is group 2; it consists basically of higher-income countries plus Syria, Turkey and Jordan.

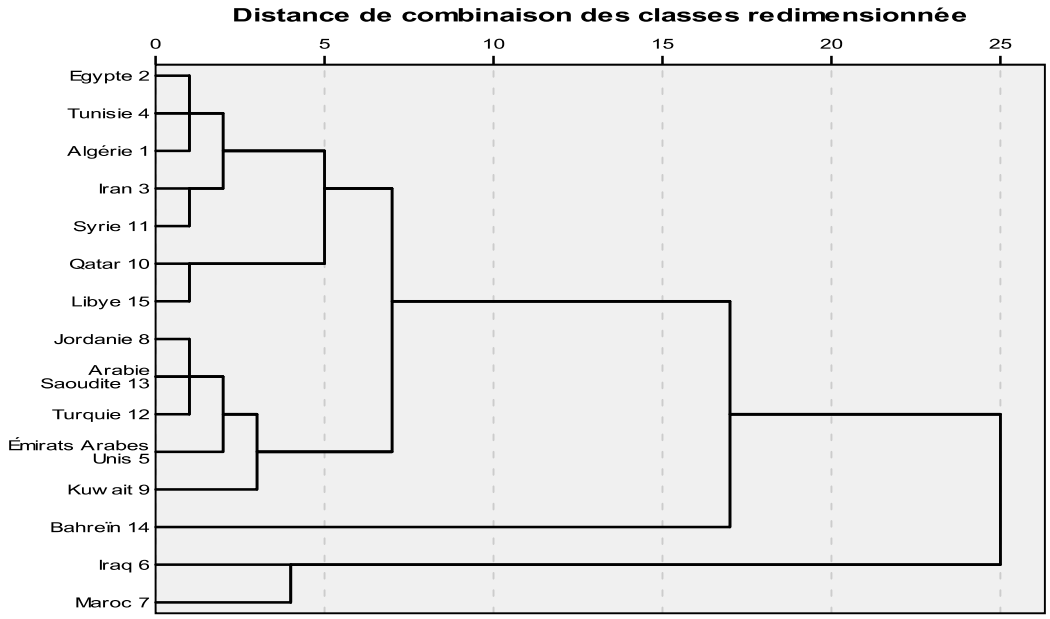


Figure 3: Classification of the MENA countries in 2010 by sex dendrogram

In 2010, Morocco and Iraq constituted the least efficient group (the most unequal countries) for both men and women (the average Gini index in this group is respectively 0.45 and 0.6). Bahrain, on the other hand, stood out from other countries by reducing the inequalities (0.18 for men and 0.22 for women). The other countries are a group whose achievements were in an intermediate situation (0.32 for men and 0.39 for women).

3.3 Inter-generational inequalities in education: Gross disparities

The database of Barro and Lee (2010) has provided us with age-group data sets; these allow us to calculate the level of inequalities by age groups.

In 2010, a highly increased Gini index for the 15-19 age group was noticed in Morocco (0.38) and a very low value in Qatar and Saudi Arabia (0.12) followed by Jordan (0.13). The most unequal age group was the 75 years and over group. This simply concerns old people who could not benefit from schooling in the sense that when they were young the majority of the MENA regions were European colonies.

So as to identify a typology concerning the countries of the MENA region according to the Gini index and to age groups, we have proceeded to classify these countries according to three age-group keys: the 15-19-year-olds (the youngest generation), the 40-44-year-olds (middle generation), and the 75 years or over group (the oldest generation). In order to analyse how dynamic the education inequality behavior is throughout the age group, we have applied this typology to two different dates: 1970 and 2010. The results are reported in Tables 5 and 6.

Table 5: Hierarchical classification of the Gini index of schooling according to age groups in 1970

Age	Groups	Number of countries	Average	Standard Deviation	F-test	Probability
15-19- year-olds	1	7	.69	.085	12.045	.001
	2	7	.46	.096		
	3	1	.69	.		
	Total	15	.58	.146		
75 and overs	1	7	.98	.023	33.541	.000
	2	7	.93	.035		
	3	1	.72	.		
	Total	15	.94	.070		
40-44-year-olds	1	7	.92	.037	14.189	.001
	2	7	.79	.067		
	3	1	.69	.		
	Total	15	.84	.092		

Source: Author's realization

In 1970, Morocco was a member of group 1. It scored the highest average in the Gini index for the three age groups (0.69 for 15-19-year-olds; 0.92 for 40-44-year-olds, and 0.98 for the 75 years and over group). Group 3 was the most efficient (less inequality) and it contained just Saudi Arabia (0.69 for 15-19-year-olds; 0.69 for 40-44-year-olds and 0.72 for the 75 years and over group). As far as the F-test is concerned, the difference between the groups is significant at 1%. For 2010, the results show certain dynamicity in the evolution of the Gini index as they decline in the three age groups (0.37 for 15-19-year-olds; 0.51 for 40-44-year-olds, and 0.94 for the 75 years and over group). If the Iraqi situation may be explained by the war that took place in that country for quite some time, the Moroccan case raises many unanswered questions. In fact, the schooling process did not meet the increasing demand for education, and the literacy programs have not yet absorb the delay observed in the elderly. The very unequal countries in 1970 (Algeria, Egypt, the United Arab Emirates, Iran and Tunisia) had leapt to an intermediate position by the year 2010. The main reason for these improvements (inequality reduction) was the reforms applied in these countries. Apparently, Bahrain was the most efficient country, as it managed to reduce the schooling inequalities for young generations (0.14) and for old people as well (0.82). Therefore, the F-test shows that the difference between the groups was significant except in the case of the 75 years and over group.

Table 6: Hierarchical classification of the Gini index of schooling according to age groups in 2010

Age	Groups	Number of countries	Average	Standard Deviation	F-test	Probability
75 and overs	1	12	.78	.113	1.839	.201
	2	2	.94	.014		
	3	1	.82	.		
	Total	15	.81	.115		
15-19- year-olds	1	12	.20	.061	8.228	.006
	2	2	.37	.014		
	3	1	.14	.		
	Total	15	.22	.083		
40-44-year-olds	1	12	.37	.067	7.465	.008
	2	2	.51	.120		
	3	1	.16	.		
	Total	15	.38	.102		

Source: Authors' realization

Altogether, we can clearly see the differences between the different countries of the MENA region. These differences are crucially marked by the effectiveness of the education policies of each country. The findings also show that disparities in education occurred even within the same country.

4. Macro-economic foundations of inequality in education: Kuznets curve of education approach

4.1 Foundations of the Kuznets curve

The pioneering work of Kuznets (1955) suggests that the inequality of revenue increases to a certain level as gradually, in proportion, as the average income. This level (called the "turning point") is where it starts to decline as the average income rises higher. A lot of arguments were settled by the works of Simon Kuznets on the relationship between income inequality and economic growth.

The first applications of the Kuznets curve in education were made by Ram (1990) and Londono (1990). Their findings suggest a verification of the Kuznets hypothesis applied in the education field. The education dispersion within the population increases to the extent that the average years of schooling rises to reach a certain level (also called the "critical point") where the dispersion declines throughout its development. In a recent work, Thomas et al. (2000) found that there is a significant negative relationship between the Gini index of education and the average years of schooling.

The implementation of the Kuznets hypothesis in the area of education requires a process of mass schooling in order to achieve a reduction of inequality in access to schooling. This study investigates how the MENA region countries are positioned in relation to this hypothesis.

It is therefore of high interest to test the shape of the Kuznets curve of this region and subsequently establish a sufficiently informative estimation of the turning point. We are going to extend these tests by taking into consideration two groups of countries: high-income and middle-income countries. This choice is more appropriate as the MENA region countries do not constitute a completely homogenous group.

Afterwards, we will carry out an empirical test on the relationship form that links the level of education inequalities and the average years of schooling. The specification of the Kuznets curve in the education field for a panel of countries is given by:

$$ei_{it} = a + b\mu_{it} + c\mu_{it}^2 + \varepsilon_{it} \quad (3)$$

where (i) represents the countries and (t) indicates the date. In order to study the shape of the Kuznets curve in the field of education in the long term, we have constructed five-year data which last from 1950 to 2010. ei refers to

the measure of inequality in the education field. We have chosen two measures: the standard deviation of school enrollments (De Gregorio and Lee, 2002; Lim and Tang, 2008; Morrison and Murtin, 2010) and the Gini index (GI) as calculated above.

Before introducing the outcomes, we are going to construct the standard deviation of schooling (proxy to inequality). We have also maintained the average years of schooling of the population μ in order to approximate the level of education. The standard deviation of the distribution of schooling (SDS) is given by the following formula.

$$SDS = \sqrt{\sum_{i=1}^{n} p_i (y_i - (\sum_{i=1}^{n} p_i y_i))^2} \tag{4}$$

and

$$\sum_{i=1}^{n} p_i y_i = \mu \tag{5}$$

The determination of the turning point μ^* is given by:

$$\frac{\partial ei}{\partial \mu} = b + 2c\mu \tag{6}$$

The requirement of the first order gives us:

$$\frac{\partial ei}{\partial \mu} = b + 2c\mu^* = 0$$
$$\mu^* = \frac{-b}{2c} \tag{7}$$

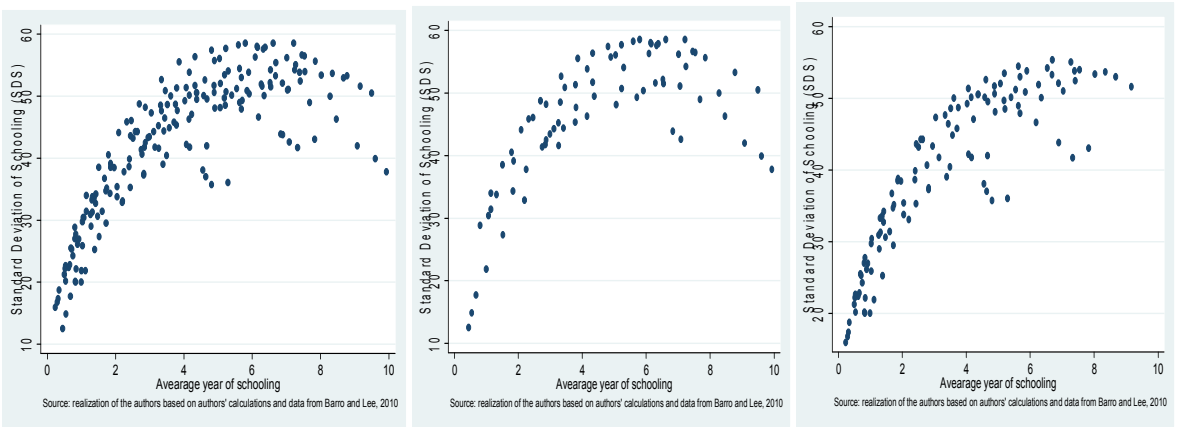
The requirement of the second order gives us:

$$\frac{\partial^2 ei}{\partial \mu^2} = 2c \tag{8}$$

4.2 The findings

4.2.1 The standard deviation of schooling as a measure of inequalities

Before introducing the empirical results, we have presented a scatter plot which is illustrated as a figure. Figure 4 is a good example of the shape of the Kuznets curve in the field of education to the dispersion of the latter and the average years of schooling for the countries of the MENA region from 1950 to 2010. The figure analysis indicates to us the validity of the Kuznets curve of education for all the countries and for each group of countries. The figure also provides us with an initial estimation of the turning point which lies between 5 and 7 years.



The whole sample High-income countries Middle-income countries

Figure 4: The Kuznets curve of education in 15 countries of the MENA region, 1950-2010

Table 7 outlines the estimate of the Kuznets curve of education on panel data. The F-test confirms the existence of individual effects.

Table 7: Estimate of the Kuznets curve of education on panel data, fixed-effects method: SDS as a dependent variable

	The whole sample	High-income countries	Middle-income countries
μ	12.157***	13.62***	11.474***
μ^2	-0. 994***	-1.114***	-0.913***
const	15.901***	14.911***	15.782***
F test	F (14.178)=28.12 Prob>F=0.0000	F (6.69)=22.04 Prob>F=0.0000	F (8.106)=27.57 Prob>F=0.0000
R-sq			
Within	0.93	0.92	0.95
Between	0.51	0.27	0.21
Overall	0.84	0.83	0.86
$\mu^* \ (\frac{-b}{2c})$	6.11	5.95	6.28

The verification of the Kuznets hypothesis in the education field suggests that the coefficient b, associated with the average years of schooling, have positive sign, and the coefficient c, associated with the average years of schooling, is with a negative sign.

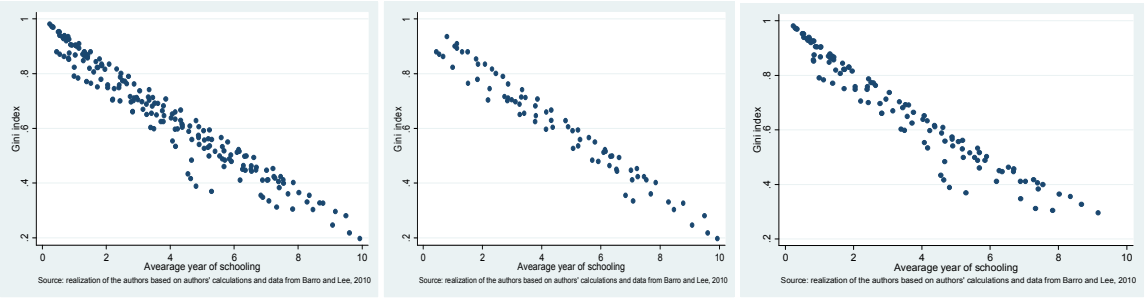
According to the econometric results shown in the table, the coefficients b and c are significant expected signs. In addition, the second derivative *(2C)* is negative, which shows that the turning point is indeed the maximum one. These results basically confirm the validity of the Kuznets curve in the education domain for the whole sample and also for the two groups of countries.

The results have also allowed us to estimate the point of diversion. This turning point is equal to 6.11 years for all the countries (the whole sample), which is equivalent to a level almost the same as the one argued in the empirical works. This value corresponds to 5.94 years in high-income countries, which is slightly below that observed in middle-income countries. Indeed, high-income countries are provided with substantial financial sources which permit them to invest more in education. They have managed to start a significant reduction of education dispersion for low levels of schooling year.

On the other hand, the middle-income countries achieve the turning point just when it comes to higher levels of education. In other words, high-income countries have already entered the phase of reducing inequalities (except for Libya), while the majority of middle-income countries have scarcely reached the turning point as shown in Figure 4.

4.2.2 The Gini index as a measurement of inequality

Our first graphical analysis has shown that the relationship between the Gini index and the average years of schooling is linear with a negative slope. The invalidity of the Kuznets curve in the education domain when the inequalities are measured by the Gini index is confirmed in the whole sample as well as in each group of countries (Figure 5). In fact, we are anticipating that the coefficient associated with the average years of schooling has a negative value, and the one associated with the squared average years of schooling has a zero value.



The whole sample High-income countries Middle-income countries

Figure 5: Gini index and the average years of schooling in 15 countries of the MENA region, 1950-2010

The results shown in the table 8 suggest that the relationship between the Gini index and the average years of schooling has a linear form with a negative and significant slope for each sample. In fact, the coefficient associated with the squared average years of schooling is almost zero for the three samples (0.001, 0.000 and 0.002 respectively for the whole sample, High-income countries and Middle-income countries). The R^2 strengthens the model's validity.

Table 8: Estimation of the Kuznets curve by using panel data, fixed-effects method: Gini Index as a dependent variable

	The whole sample	High-income countries	Middle-income countries
μ	-0.092***	-0.07***	-0.103***
μ^2	0.001***	0.000	0.002***
const	0.972***	0.943***	0.979***
F test	F (14.178)=41.32	F (6.69)=17.94	F (8.106)
	Prob>F=0.0000	Prob>F=0.0000	Prob>F=0.0000
R-sq			
Within	0.98	0.98	0.99
Between	0.73	0.95	0.74
Overall	0.94	0.96	0.95

5. Conclusion and implications

In this work, we have calculated the Gini index of education in some countries of MENA region according to the criteria of gender, age and the income levels. The achieved results have indicated that educational inequalities are explicitly decreased for all the countries, for both men and women and for all age-groups. The findings have also shown that the distribution of education is more unequal in middle-income countries than in high-income countries in 2010 while they had almost the same level in 1970.

In a second step, we estimated the Kuznets curve of education inequality for the countries of the region. The findings show that the shape of the Kuznets curve depends on the measure used to approximate inequality. Indeed, the Kuznets curve hypothesis is applicable if we use the standard deviation of schooling. The Gini index, for its part, has maintained a meaningful negative relationship with the average number of years of schooling.

These results have strong implications in terms of economic policy. For high-income countries, future efforts should focus on the reduction of inequalities in men's education, whereas in middle-income countries, the educational policies should offer programs aimed at reducing the total inequality with a particular focus on decreasing that of women.

The differences noticed between the countries lead us to assume the existence of other differences even within the same country. For instance, Amaghouss and Ibourk (2011) have calculated the education Gini index and the average years of schooling of Moroccan provinces in 2004. From these calculations, it is revealed that both Fes and Moulay Yacoub provinces (located in the Fes-Boulemane region) recorded contradictory achievements in terms of reducing inequality. As a matter of fact, the province of Fes is classified among the ten least unequal provinces, compared to Moulay Yacoub which is classified amongst the ten most unequal provinces. Therefore, this is a current controversial issue to be considered in the future works.

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Box 1: The hierarchical classification system

The hierarchical classification system is a multidimensional analysis technique which allows data tables to be processed outright whereby any individual is defined by several variables.

The choice of the variables that will represent the individuals are shaped according to the nature of the data.

-If the data are arranged according to the standards of p numerical variables and n individuals we will state that:

-The agglomerative hierarchical clustering of individuals from p variables is centered and scaled.

-The agglomerative hierarchical clustering of individuals from p factors is obtained by using a Component Principal Analysis normed on p variables.

-If the data are arranged in the form of a contingency table, we will realize agglomerative hierarchical cluster of linear terms from the linear terms results obtained by the CPA. Moreover, we can also carry out a hierarchical cluster of column terms.

There are several ways to calculate the similarity and the difference between the individuals i and j:

– Euclidean distance formula for measuring is the most commonly used type. It is represented as follows:

$$d(I_i, I_j) = \sqrt{\sum_k (x_{ik} - x_{jk})^2}$$

– Squared Euclidean distance is used to calculate "over-weighted" atypical individuals

$$d(I_i, I_j) = \sum_k (x_{ik} - x_{jk})^2$$

- City-block distance (Manhattan distance): $d(I_i, I_j) = \sum_k |x_{ik} - x_{jk}|$

- Tchebychev distance: $d(I_i, I_j) = Max \quad |x_{ik} - x_{jk}|$

- Distance to the power system: $d(I_i, I_j) = \left(\sum_k |x_{ik} - x_{jk}|^p \right)^{1/r}$

-When data sets are in a categorical form, we calculate "percent disagreement" $d(I_i, I_j) = \frac{Number \quad x_{ik} \neq x_{jk}}{K}$

- 1-r of Pearson: calculated basically with the correlation coefficient formula: $d(I_i, I_j) = 1 - r_{ij}$

The first group will then be formed by bringing together the individuals whose distance is minimal.

After calculating the mutual distances between individuals, we calculate the "distance" or the dissimilarity index between a certain individual and a group or between two groups (A and B).

– Minimum jump: $D(A, B) = \min_{I \in A} \min_{J \in B} d(I, J)$

- Maximum distance: $D(A, B) = \max_{I \in A} \max_{J \in B} d(I, J)$

- Unweighted average of associated groups: $D(A, B) = \frac{1}{n_A n_B} \sum_{I \in A, J \in B} d(I, J)$

- Weighted average of associated groups: $D(A, B) = \frac{1}{(n_A + n_B)(n_A + n_B - 1)} \sum_{I, J \in A \cup B} d(I, J)$

- Ward's method, which claims that if a certain group (M) has been obtained as a result of combining two groups (K) and (L), its distance from group (J) is given by:

$$D(M, J) = \frac{(N_J + N_K) D(K, J) + (N_J + N_L) D(L, J) - N_J D(K, L)}{N_J + N_K + N_L}$$

The dendrogram allows us to see the different possible groupings. It also gives us the aggregation index scale at each aggregation level. A group is identified by cutting a line limit after the aggregations corresponding to the lower values of the index and before the aggregations corresponding to the higher values.