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Interdependencies of Health, Education and Poverty: The Case of South Mediterranean Economies*

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ABSTRACT

This study is devoted to assessing the interdependencies between health, education and wealth at the aggregate regional level of South Mediterranean Countries (SMC) for the purpose of strengthening transversal economic and social policies. It looks first, to the major contributions of the previous literature developed on this subject. Theoretical and empirical studies at micro and macroeconomic levels prove that there are causal relations between variables related to health, education and wealth. As long as only partial and limited evidence exists on these interdependencies for the SMC, the second part is an empirical analysis based on World Bank, United Nations and on composite international indices. The results show that large interdependencies appear to be consistently exhibited by the data. Also, in the Granger sense of causality, health and education have been revealed to have important effects in leading these economies. The results attained are likely contributions for the enhancement of the economic and social policies to strengthen human development in the region.

***Keywords**:* Health, Education, Poverty, Granger causality.

Interdependencias de salud, educación y pobreza: el caso de las economías Sur-Mediterráneas

RESUMEN

Este estudio está dedicado a evaluar las interdependencias entre la salud, la educación y la riqueza al nivel regional en el conjunto de los países mediterráneos del sur, con el objetivo de reforzar las políticas económicas y sociales transversales. En primer lugar, se atiende a las principales contribuciones desarrolladas hasta el momento sobre este asunto. Estudios teóricos y empíricos a niveles micro y macroeconómicos comprueban la existencia de relaciones causales entre variables relacionadas con la salud, la educación y la riqueza. No obstante, como sólo hay evidencia parcial y limitada sobre la existencia de estas interdependencias para el SMC, la segunda parte es un análisis empírico basado en la información del Banco Mundial, de las Naciones Unidas y en índices internacionales compuestos. Los resultados muestran que las interdependencias parecen ser sustentadas por los datos. Además, en el sentido de la causalidad Granger, salud y educación parecen tener efectos importantes liderando esas economías. Los resultados obtenidos pretenden contribuir a mejorar las políticas económicas y sociales dirigidas a reforzar el desarrollo humano en la región.

***Palabras claves**:* salud, educación, pobreza, causalidad de Granger.

Clasificación JEL: I1, I2, I3.

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1. INTRODUCTION

This study aims at analyzing the interdependencies existing between human development factors with a special focus on health, education and traditional economic variables that include income poverty. This serves as a preliminary step towards providing evidence for strengthening transversal development policies, and especially those related to health and education.

If empirical research has been accumulated on different regions of the world, only partial and limited evidence exists on these interdependencies for the South Mediterranean Countries (SMC)[1]. The Arab human development reports (UNDP 2002, 2003, 2004 and 2005) have shown the existence of large deficits in different aspects of human development in this region. Health and knowledge appear to be among the major deficits and occupy key positions in limiting access to better lives. The most recent World Bank report on education (2008) shows clearly the level of efforts needed to promote knowledge in this region of the world. In addition, the World Bank report by Ayodeji Akala F. and El-Saharty S. (2006) underlined the level of health deficits occurring in the South Mediterranean economies.

Insights into these inter-related issues have been building, with the development of both theoretical and empirical studies focusing on interdependencies and the development of new challenges facing policy-makers.

The present paper is a contribution to the assessment of the interdependencies through aggregated data related to the SMC. After this introduction (1) the study is developed under two sections. The first one (2) looks at the major contributions of the previous literature developed on interdependencies. The second section (3) analyses empirically the interdependencies between health, education and economic related variables (poverty). It includes respectively results related to the use of World Bank data, United Nations data and composite indices. The last set of results focuses on testing for Granger Causality. Each subsection of results starts with a description of the data and variables used.

2. LITERATURE REVIEW

The importance of health and education has been recognized since the early work of Sen A. (1998). In a later publication, Osmani S. and Sen A. (2005) looked at the fetal origins of ill-health through analyzing the hidden penalties of gender issues.

Since 2000, the international community has embarked in achieving the Millennium Development Goals (MDGs). These goals cover poverty, illiteracy, health, education and environment among others. Since the publication of the first world human development report in 1990, more emphasis has been placed on the

[1] The countries covered by the study are: Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Syria, Tunisia, Turkey, United Arab Emirates, and Yemen.

monitoring of human development as it is annually covered in world, regional and country reports. These trends imply that most developing countries, including SMC, have been involved in policies and actions aiming at promoting better livelihoods for their populations. As they are developed in different empirical reports and studies, the human development policies do have important interdependencies that should be better identified. These identifications help refine the knowledge and the directions of policy actions that could enhance the level of attainment of the MDG's, as well as the enhancement of the living conditions of the populations.

There are major wealth components and their interdependencies that have been identified. Beach C. et al. (2006) introduced at least three basic sets of variables (health, education, and economics) as interdependent causes and consequences of one another over the lifetime of individuals, households and economies. Hurd M. and Kapteyn A. (2003) accounted not only for economic variables with health, but also for all of the other socioeconomic factors, including education. These authors integrated most of the variables that could relate to health and explored the causality among all these factors. Adams P. et al. (2003) identified causal relationships between socioeconomic status (SES) and health conditions, even if the attained results presented some inconsistencies.

Kim H. and Lee J. (2007) conducted a longitudinal analysis to detect the long-term effect of health shocks on wealth and compared that with its short-run impacts on the elderly, as in the previous study of Adams P. et al. (2003). New health events were found to have negative impacts on wealth, but the decline occurred over time (Kim H. and Lee J., 2007). This latter paper also illustrated how severe health conditions (existing and new) significantly influenced wealth depletion, mainly under late shocks in life. Moreover, health capital (existing severe chronic conditions) appeared to exhibit persistent negative impact on wealth changes over time. However, these results were subject to variations in the level of education, the family status, and other factors.

Longer-term effects were investigated using panel data by Adams P. et al. (2002) and Culter D., Miller G. and Norton D. (2007). Only limited evidence was attained, as also shown in other studies by Cutler D. et al. (2007) and in Mayer-Foulkes D. (2004). The latter addressed the long-term impact of health by including the intergenerational and life-long dimensions.

Cutler D., Lleras-Muney A., and Vogl T. (2008) illustrated the existence of a clear link between SES and health, as identified in several papers across the United States and European Countries. A series of socioeconomic variables such as education, income, occupation, race and ethnicity were used as measures of SES, in association with poor health and increased mortality risk. Among the findings, mortality risk increased with individuals who did not reach upper secondary education in the United States and in some European Countries. In addition, Cutler D. et al. (2008) reviewed research of the last two decades on the SES health gradient by focusing on the mechanisms through which SES measures affected the

health status. Among the other results attained by the latter authors, the characteristics of developing countries appeared to be determinant (Cutler D., Lleras-Muney A. and Vogl T., 2008).

Other studies, such as the one by Grossman M. (2005), analyzed the impact of education on non-market outcomes. The outcomes discussed included general consumption, savings, the rate of growth of consumption overtime, own health, and inputs into the production of own health, fertility, child health and cognitive development.

In an earlier effort, Duncan T. and Strauss J. (1998) looked at the relationship between health, nutrition and development. The authors focused on education and health as both related to labor market successes. While the link between education and labor market was largely studied, that between health and labor market successes received less attention. The latter link is particularly important for developing economies. For the above authors, various models related nutrition, productivity and wage, with marginal productivity of health higher in developing countries because the health levels were lower and the nature and prevalence of diseases, such as malnutrition, was higher. Children in developing countries were recognized as more likely to be ill, and the health of adults was more likely to depend on early life conditions. Thus, in the context of the developing world, the consequences of lower health would be more pronounced for the poor.

The large body of investigations related to the interdependencies of health, education and poverty demonstrated that the contributions are mostly empirical with the prevalence of only few theoretical models. The most important theoretical contributions identified were those of Gan L. and Gong G. (2007), Chakraborty S. and Das M. (2004) and Chen W., Engineer M. and King I. (2006). But, as stated by Cutler D. and Lleras-Muney A. (2006), not all of the existing theories were tested, and most of the empirical work was not supported by theory.

3. THE EMPIRICAL RESULTS

The results introduced in this section are respectively based on data from World Bank, United Nations and on composite international indices. The empirical analysis begins with some simple regression models applied on World Bank database. Then, the analysis continues by introducing in the models more variables related to health, education and wealth from UN database. In order to study the interrelations between all the variables, a Principal Component Analysis is performed and related regression models performed. Composite indices describing education, health and wealth are also considered using multiple regressions. Attempt to establish directions of causality is made using Granger causality test.

The sets of data used are described before the introduction of their corresponding results.

3.1. Results based on World Bank data

These results are shown and discussed after a description of the data used.

3.1.1. *World Bank dataset*

The education indicators used relate to three main fields: education outcomes, participation in education, and education inputs. The education outcomes variables are assessed by the total adult literacy rate (age 15 and above) and the total youth literacy rate (from age 15 to age 24). The two measures of education outcomes only cover the year 2004. Concerning measures of participation in education, they include the number of children out of school during primary education in 2000, the mean years of schooling (age 15 and above) in 2000, the pre-primary school life expectancy in years (from 1999 to 2004), and the primary to tertiary school life expectancy in years (from 1999 to 2004). The mean years of schooling provides an indication of skills acquired during an estimated average period in school. The pre-primary school life expectancy represents the numbers of years that a pre-primary-age child should expect to spend in his/her pre-primary school. The primary to tertiary school life expectancy predicts the expected numbers of years that an enrolled student should spend from primary to tertiary education. Education inputs were only illustrated by the pupil-teacher ratio from 1999 to 2004, which represent the number of students enrolled within primary schools over the number of primary education teachers. The indicators used for education include the adult literacy rate, children out of primary school, mean years of schooling, pre-primary school life expectancy, primary to tertiary school life expectancy, pupil-teacher ratio and youth literacy rate.

TABLE 1
World bank data set.

Education	Year
The total adult literacy rate (age 15 and above)	2004
The total youth literacy rate (from age 15 to age 24)	2004
The number of children out of school during primary education	2000
The mean years of schooling (age 15 and above)	2000
The pre - primary school life expectancy in years	1999-2004
The primary to tertiary school life expectancy in years	1999-2004
Health	
The crude death rate per 1,000 people	1995, 2000, 2004
The infant mortality rate per 1,000 live births	1995, 2000, 2004
The under five mortality rate per 1,000	1995, 2000, 2004
The total life expectancy at birth in terms of years	1995, 2000, 2004
Wealth	
GDP per capita	2006

Health measurements cover three major topics: population dynamics, mortality, and reproductive health. The population dynamics is drawn from the crude death rate per 1,000 people. The death rate gives the estimated number of deaths per 1,000 people in a country at mid-year. Mortality is illustrated with the following indicators: infant mortality rate per 1,000 live births, under-five mortality rate per 1,000, and total life expectancy at birth in terms of years. Both infant and under-five mortality rates have available statistics from 1995, 2000, and 2004. The life expectancy at birth covers the same years as the death rate. The infant mortality rate represents the number of children dying before their first year out of 1,000 live births within a year. The under-five mortality rate is the probability that a child would die before reaching their fifth year, knowing that the child is subject to the actual age-specific mortality rates. Life expectancy at birth embodies the probability that a born infant would live, given that the mortality conditions stay the same from the day of the child's birth to death. Reproductive health is portrayed by the maternal mortality ratio per 100,000 live births. This only covers 1995 and 2000, and shows the number of mothers who die because of pregnancy and childbirth of 100,000 live births. The health indicators used include: death rate, infant mortality rate, life expectancy at birth, maternal mortality ratio and under-five mortality rate.

Due to the inconsistency and unavailability of income indicators, only the Gross Domestic Product (GDP) per capita was taken into account as a measurement of income.

3.1.2. *Results related to Health and wealth/poverty relationships*

In a first set of regressions with the number of countries (N = 17), the relationships between health measures, represented by life expectancy at birth and by indices of mortality and wealth measured by GDP per capita, are estimated. The results show that life expectancy at birth is strongly related to GDP per capita and its square, implying that life expectancy at the level of this region of the world is directly under the effect of GDP per capita, and that an increase (decrease) of 1 leads to a net increase (decrease) of life expectancy by 0.45. This same measure of wealth also explains under-five mortality rate, and an increase (decrease) of GDP by 1 unit decreases (increases) this variant of mortality by 0.74 units. The obtained result also demonstrates the existence of a strong positive relationship between GDP and the number of physicians per 1,000 people. This clarifies the other results, where female adult mortality, maternal mortality ratio, life expectancy at birth and others are explained either by per capita GDP or by the number of physicians. Table 2 introduces the most important relationships between variables related to health and wealth/poverty. The results correspond to estimates with 1% significance levels with the related t-statistic as indicated below each coefficient.

These estimations show that under their logarithmic forms, life expectancy at birth and GDP are directly related. They entertain a quadratic relationship with a

negative elasticity for the squared GDP (-0.02), and a positive one for GDP (0.47), implying a longer run elasticity of 0.45. This result confirms the estimations made elsewhere (Deaton 2006) that are represented by the Preston Curve (1996). The results show also that GDP is positively related to "the number of physicians per 1,000 people" with a 0.53 elasticity. A positive elasticity is also obtained between life expectancy at birth and the number of physicians (0.09). Otherwise, high levels of elasticity are attained when estimating equations related to mortality rates. Under-five mortality rate exhibits a -0.74 with GDP and -0.99 with the number of physicians. Maternal mortality ratio with GDP exhibits an elasticity of -1.19. Female adult mortality rate with GDP shows a level of elasticity that is around -0.36. These results clearly show that improvements (decreases) in GDP are likely to generate better (lower) health conditions for both mothers and children in this region. While "the number of physicians" is positively related to GDP, any reduction (enhancement) due to other mechanisms (brain drain for example) increases (decreases) the mortality rate. These interdependencies are important for understanding the relationships between economic and health components.

TABLE 2
Health and Wealth/Poverty relationships.

	R^2	N
Ln (Life Exp at Birth) $= \underset{(2.04)}{1.82} + \underset{(2.44)}{0.47}\, Ln$ (GDP per capita) $- \underset{(-2.12)}{0.02}\, Ln$ (GDP per capita)^2	0.73	17
Ln (Under 5 mortality rate) $= \underset{(6.47)}{9.78} - \underset{(-4.79)}{0.74}\, Ln$ (GDP per capita)	0.47	17
Ln (Physicians per 1000) $= \underset{(-4.42)}{-4.53} + \underset{(5.02)}{0.53}\, Ln$ (GDP per capita)	0.49	17
Ln (GDP per capita) $= \underset{(43.05)}{9.20} + \underset{(4.29)}{1.02}\, Ln$ (Physicians per 1000)	0.50	17
Ln (Under 5 mortality rate) $= \underset{(16.82)}{3.17} - \underset{(-4.84)}{0.99}\, Ln$ (Physicians per 1000)	0.47	17
Ln (Life Exp at Birth) $= \underset{(344.02)}{4.27} + \underset{(6.61)}{0.09}\, Ln$ (Physicians per 1000)	0.70	17
Ln (Life Exp at Birth) $= \underset{(208.52)}{4.46} - \underset{(-7.42)}{0.06}\, Ln$ (Under 5 mortality rate)	0.68	17
Ln (Female adult mortality rate) $= \underset{(18.14)}{7.94} - \underset{(-8.06)}{0.36}\, Ln$ (GDP per capita)	0.72	17
Ln (Maternal mortality ratio) $= \underset{(11.02)}{14.96} - \underset{(-8.55)}{1.19}\, Ln$ (GDP per capita)	0.74	17

Notes: 1. t-stat between parentheses; 2. N refers to the number of countries included in the regressions. These results correspond to 1 % significance level.

The introduction of the education component into the system of relationships may be an important source for the explanation of further levels of interdependencies.

3.1.3. *Results related to education, health and income/poverty*

Using the other available sources of data for variables related to education, income, unemployment and other health variables for the countries under study, a system of relationships have been estimated. Here, the number of observations (N) is reduced to 13 and 15 because of missing information on some variables for a large number of SMC. The level of enrollment in primary school appears to be under the effect of both health and wealth variables. It is also affected by poverty, as measured by the Human Poverty Index (HPI)[2]. The Human Development Index (HDI)[3] is directly related to high enrollment. Poverty and bad health negatively affect the level of enrollment at the primary school. Similarly, infant mortality rate is sensitive to both income and education. The levels of unemployment do affect infant mortality. Finally, the level of corruption, as measured by the Corruption Perception Index (CPI)[3], appears to be negatively related to income. The results described above are introduced in Table 3 (t-statistic indicated below the estimated coefficients at a 1% significance level).

TABLE 3
Education, Health and Income/poverty.

	R^2	N
Ln (% Enrolment primary) $= \underset{(5.21)}{6.14} - \underset{(-2.64)}{0.20}$ [*Ln* (Low birth weight)] $- \underset{(-2.08)}{0.07}$ [*Ln* (GNI)]	0.64	17
Ln (% Enrolment primary) $= \underset{(6.51)}{7.21} - \underset{(-2.94)}{0.23}$ [*Ln* (Low birth weight)] $- \underset{(-2.04)}{0.10}$ [*Ln* (HPI)]	0.46	17
Ln (Infant Mortality) $= \underset{(-2.39)}{-0.23}$ [*Ln* (Income)] $- \underset{(-2.46)}{0.26}$ [*Ln* (% Education)]	0.84	13
Ln (% Enrolment primary) $= \underset{(20.51)}{5.67} - \underset{(-3.26)}{0.18}$ [*Ln* (Low birth weight)] $+ \underset{(2.06)}{0.26}$ [*Ln* (HDI)] $- \underset{(-2.94)}{0.07}$ [*Ln* (GNI)]	0.58	17
Ln (Infant Mortality) $= \underset{(-3.49)}{-0.21}$ [*Ln* (Income)] $+ \underset{(3.21)}{1.29}$ [*Ln* (Unemployment)]	0.86	13
Ln (Unemployment) $= \underset{(-9.02)}{-3.40} - \underset{(-2.98)}{0.54}$ [*Ln* (Poverty rate)]	0.39	15
Ln (Income) $= \underset{(-2.80)}{-7.90} + \underset{(6.39)}{5.76}$ [*Ln* (CPI)]	0.84	13

Notes: 1. t-stat between parentheses; 2. N refers to the number of countries included in the regressions

3.2. Robustness checks using the most recent database of the United Nations

The results are shown after a description of data.

[2] UNDP, Human Development Report 2007/2008 http://hdrstats.undp.org/indicators/18.html

[3] Transparency International, Corruption Perceptions Index, 2008 http://www.transparency.org/news_room/in_focus/2008/cpi2008.

3.2.1. *Description of the Dataset*

In order to see how the variables associated to health, education and wealth are interrelated, 32 variables from United Nations (UN) are used for 16 South Mediterranean Countries. The variables under their logarithmic forms are divided in six groups that include:

- *Preventive health*: Improved Drinking Water Coverage and Improved Sanitation Coverage.
- *Health state*: Maternal Mortality Ratio, Life Expectancy at Birth, Infant Mortality Rate, Under 5 Mortality Rate.
- *Education level*: School Life Expectancy, Literacy Rate, Youth (15-24) Literacy Rate.
- *Economic activity*: Adult (15+) Economic Activity Rate, Adult (15+) Unemployment Rate.
- *Wealth or poverty variables*: Per Capita GDP.
- *Population dynamics*: Total Fertility Rate, Population Distribution, Annual Rate of Population Change.

A detailed description of the variables is introduced in the following table (Table 4).

TABLE 4
United Nations data set.

Nr.	Variable	Group	Year
V1	Total Fertility Rate	*population dynamics*	2005-2010
V2	Maternal Mortality Ratio	*health state*	2000
V3	Total "School Life Expectancy (in years)"	*Education level*	2005-2006
V4	Men "School Life Expectancy (in years)"	*Education level*	2005-2006
V5	Women "School Life Expectancy (in years)"	*Education level*	2005-2006
V6	Life Expectancy at Birth "Men"	*health state*	2005-2010
V7	Life Expectancy at Birth "Women"	*health state*	2005-2010
V8	Infant Mortality Rate	*health state*	2005-2010
V9	Under 5 Mortality Rate	*health state*	2005-2010
V10	Population Distribution (%) "Urban"	*population dynamics*	2008
V11	Population Distribution (%) "Rural"	*population dynamics*	2008
V12	Annual Rate of Population Change (%) "Urban"	*population dynamics*	2005-2010
V13	Annual Rate of Population Change (%) "Rural"	*population dynamics*	2005-2010
V14	Per Capita GDP (US$)	Wealth/poverty	2006

TABLE 4 (Continuation)
United Nations data set.

Nr.	Variable	Group	Year
V15	Adult (15+) Economic Activity Rate "Total"	*economic activity*	2005-2010
V16	Adult (15+) Economic Activity Rate "Men"	*economic activity*	2005-2010
V17	Adult (15+) Economic Activity Rate "Women"	*economic activity*	2005-2010
V18	Adult (15+) Literacy Rate "Total"	*Education level*	2004-2007
V19	Adult (15+) Literacy Rate "Men"	*Education level*	2004-2007
V20	Adult (15+) Literacy Rate "Women"	*Education level*	2004-2007
V21	Youth (15-24) Literacy Rate "Total"	*Education level*	2004-2007
V22	Youth (15-24) Literacy Rate "Men"	*Education level*	2004-2007
V23	Youth (15-24) Literacy Rate "Women"	*Education level*	2004-2007
V24	Adult (15+) Unemployment Rate "Total"	*economic activity*	2000-2005
V25	Adult (15+) Unemployment Rate "Men"	*economic activity*	2000-2005
V26	Adult (15+) Unemployment Rate "Women"	*economic activity*	2000-2005
V27	Improved Drinking Water Coverage (%) "Total"	*Preventive health*	2004
V28	Improved Drinking Water Coverage (%) "Urban"	*Preventive health*	2004
V29	Improved Drinking Water Coverage (%) "Rural"	*Preventive health*	2004
V30	Improved Sanitation Coverage (%) "Total"	*Preventive health*	2004
V31	Improved Sanitation Coverage (%) "Urban"	*Preventive health*	2004
V32	Improved Sanitation Coverage (%)	*Preventive health*	2004

Note: The most recent value (the last year available) for each country.

3.2.2. *Using principal component analysis*

Basically, the question pursued here is whether or not health, education and economic variables are interrelated. For that purpose, a Principal Component Analysis (PCA) is used. The results show that 85.36% of the information is preserved by the projection of the variables on the plan composed by the first two principal components. The first and second components are determined by the variables that attain a value close to one on the corresponding column (Table 5).

TABLE 5
Rotated component matrix (PCA).

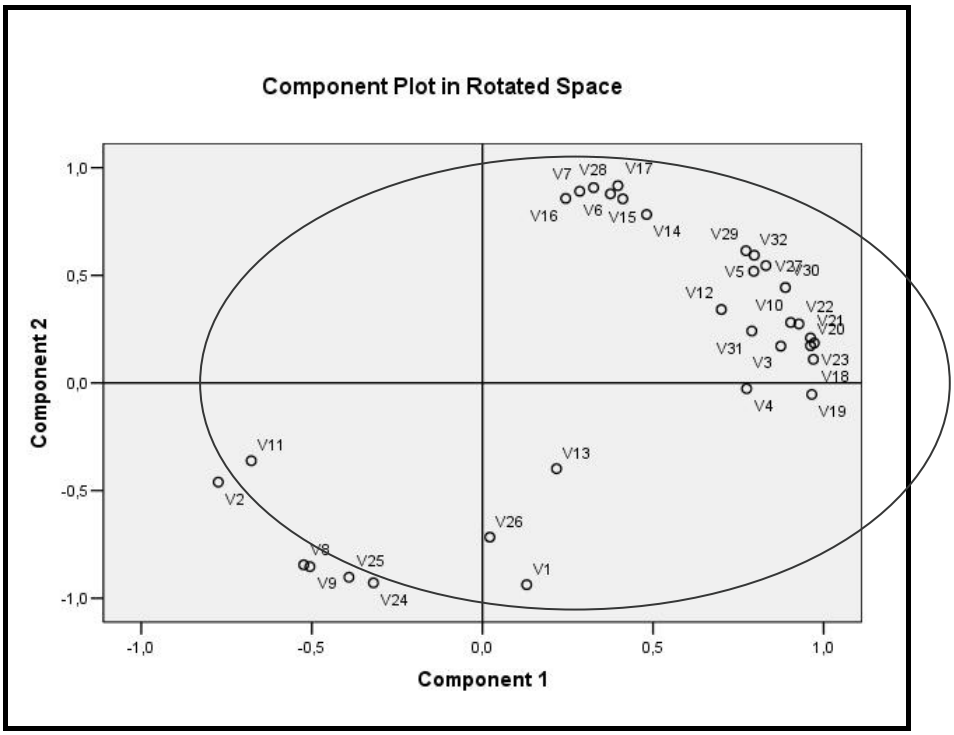
	Component	
	1	2
V1: Total Fertility Rate	0,130	**–0,937**
V2: Maternal Mortality Ratio	–0,774	–0,461
V3: Total "School Life Expectancy (in years)"	**0,875**	0,171
V4: Men "School Life Expectancy (in years)"	0,774	–0,027
V5: Women "School Life Expectancy (in years)"	0,795	0,519
V6: Life Expectancy at Birth "Men"	0,375	**0,879**
V7: Life Expectancy at Birth "Women"	0,285	**0,891**
V8: Infant Mortality Rate	–0,524	**–0,845**
V9: Under 5 Mortality Rate	–0,506	**–0,853**
V10: Population Distribution (%) 2008 "Urban"	**0,903**	0,281
V11: Population Distribution (%) 2008 "Rural"	–0,678	–0,361
V12: Annual Rate of Population Change (%) 2005-2010 "Urban"	0,700	0,341
V13: Annual Rate of Population Change (%) 2005-2010 "Rural"	0,217	–0,399
V14: Per Capita GDP (US$)	0,481	0,783
V15: Adult (15+) Economic Activity Rate "Total"	0,411	**0,855**
V16: Adult (15+) Economic Activity Rate "Men"	0,244	**0,857**
V17: Adult (15+) Economic Activity Rate "Women"	0,397	**0,917**
V18: Adult (15+) Literacy Rate "Total"	**0,970**	0,110
V19: Adult (15+) Literacy Rate "Men"	**0,965**	–0,053
V20: Adult (15+) Literacy Rate "Women"	**0,962**	0,173
V21: Youth (15-24) Literacy Rate "Total"	**0,962**	0,209
V22: Youth (15-24) Literacy Rate "Men"	**0,928**	0,274
V23: Youth (15-24) Literacy Rate "Women"	**0,973**	0,185
V24: Adult (15+) Unemployment Rate "Total"	–0,320	**–0,929**
V25: Adult (15+) Unemployment Rate "Men"	–0,391	**–0,903**
V26: Adult (15+) Unemployment Rate "Women"	0,022	–0,717
V27: Improved Drinking Water Coverage (%) "Total"	**0,831**	0,545
V28: Improved Drinking Water Coverage (%) "Urban"	0,326	**0,908**
V29: Improved Drinking Water Coverage (%) "Rural"	0,772	0,614
V30: Improved Sanitation Coverage (%) "Total"	**0,888**	0,443
V31: Improved Sanitation Coverage (%) "Urban"	0,790	0,241
V32: Improved Sanitation Coverage (%) "Rural"	0,797	0,593

Note: The PCA was run under SPSS software.

The first principal component is determined mainly by the variables related to "education level" and "preventive health" (V3, V10, V18, V19, V20, V21, V22, V23, V27, V30). These variables are strongly related one to another. Literacy rates and school life expectancy are directly correlated with "improved drinking water coverage", "improved sanitation coverage" and "population distribution in urban areas".

The second principal component is determined essentially by the variables related to "health state" and "economic activity" (V1, V6, V7, V8, V9, V15, V16, V17, V24, V25, V28). Life expectancy is directly correlated with economic activity and inversely correlated with unemployment rate. Mortality rates (Infant mortality rate, Under 5 mortality rate) are inversely correlated with economic activity and directly correlated with unemployment rates. Figure 1 shows graphically the plot of different variables relative to the two principal components.

FIGURE 1
First two Principal Components in Rotated Space.



3.2.3. *Regression analysis*

A second question is adressed here with respect to how the six groups of variables are interrelated. In order to provide further evidence on the existence of major interdependencies between health, education and economic sets of variables, a system of equations is estimated using the UN database.

The results obtained previously are used for the identification of the best correlations between the endogenous and exogenous variables and for avoiding multicolinearity. As variables are expressed under logarithmic forms, elasticity can be directly estimated (t-statistics are shown below each estimated coefficient under a 1 % significance level).

TABLE 6

Estimations based on the most recent UN-database for the South Mediterranean Countries.

Equation	Regression	N	R^2
1.	$V2 = \underset{(5.01)}{66.93} - \underset{(-1.50)}{4.91} \cdot V14 - \underset{(-2.54)}{9.46} \cdot V5$	15	0.647
2.	$V2 = \underset{(2.46)}{7.89} \cdot V14 - \underset{(-2.14)}{6.91} \cdot V23$	14	0.947
3.	$V6 = \underset{(6.16)}{2.53} \cdot V14 - \underset{(-1.61)}{1.20} \cdot V18$	12	0.983
4.	$V7 = \underset{(-1.84)}{-0.72} \cdot V14 + \underset{(4.25)}{1.73} \cdot V5$	16	0.999
5.	$V8 = \underset{(3.88)}{3.20} - \underset{(-1.80)}{0.36} \cdot V14 + \underset{(2.91)}{0.67} \cdot V5$	15	0.414
6.	$V8 = \underset{(6.13)}{1.62} \cdot V14 - \underset{(-2.47)}{0.656} \cdot V23$	14	0.999
7.	$V9 = \underset{(-2.11)}{-1.63} \cdot V14 + \underset{(3.10)}{2.56} \cdot V5$	16	0.996
8.	$V9 = \underset{(3.50)}{3.18} \cdot V14 - \underset{(-2.66)}{2.42} \cdot V20$	12	0.996
9.	$V9 = \underset{(4.87)}{2.73} \cdot V14 - \underset{(-3.52)}{1.99} \cdot V23$	14	0.947
10.	$V27 = \underset{(-2.03)}{-3.24} + \underset{(1.92)}{0.82} \cdot V14 + \underset{(1.48)}{0.43} \cdot V15 + \underset{(1.28)}{0.486} \cdot V5$	12	0.895
11.	$V30 = \underset{(8.09)}{14.63} - \underset{(-9.34)}{5.91} \cdot V14 + \underset{(15.46)}{2.87} \cdot V15 - \underset{(-3.42)}{0.1} \cdot V18$	10	0.984
12.	$V6 = \underset{(-2.08)}{-5.63} \cdot V14 + \underset{(2.76)}{7.6} \cdot V27$	12	0.988
13.	$V2 = \underset{(5.03)}{11.08} \cdot V14 - \underset{(-4.56)}{10.22} \cdot V27$	12	0.977
14.	$V9 = \underset{(4.81)}{4.8} \cdot V14 - \underset{(-3.77)}{3.92} \cdot V30$	12	0.971
15.	$V3 = \underset{(-1.79)}{-3.45} + \underset{(2.04)}{1.08} \cdot V14 + \underset{(1.29)}{0.24} \cdot V12$	15	0.619
16.	$V21 = \underset{(-2.53)}{-4.91} + \underset{(3.23)}{1.69} \cdot V14 + \underset{(2.01)}{0.37} \cdot V12$	11	0.84
17.	$V1 = \underset{(4.12)}{21.27} - \underset{(-3.99)}{4.67} \cdot V5 - \underset{(-1.95)}{0.23} \cdot V17$	11	0.70

Note: 1. t-stat between parentheses; 2. N refers to the number of countries included in the regressions

Income and education are often considered "fundamental" determinants of health. The "maternal mortality rate" appears to be more sensitive to improvements in women education represented by "Women School Life Expectancy" than to "wealth/poverty" expressed by "GDP per capita" (elasticity of –9.46 compared to –4.91). If education is measured by "Youth literacy rate for Women", the maternal mortality rate is more sensitive to "wealth/poverty" than to education (elasticity of 7.89 compared to –6.91) (Table 6, equations 1-2).

Life expectancy at birth for men is more sensitive to wealth/poverty than to education expressed by Adult (15+) Literacy Rate "Total" (elasticity of 2.53 compared to –1.2) while life expectancy at birth for women is more sensitive to education represented by "Women School Life Expectancy" than to wealth/poverty (elasticity of 1.73 compared to –0.72) (Table 6, equations 3-4).

The infant mortality rate seems to be relatively inelastic with respect to wealth/poverty and education as expressed by school life expectancy (elasticity under 1 in absolute value). With respect to education measured by "Youth literacy rate for Women", the infant mortality rate is relatively elastic (elasticity of 1.62) (Table 6, equations 5-6).

"Under 5 Mortality Rate" is highly responsive to "wealth/poverty" expressed by GDP per capita and to education expressed by "women school life expectancy (in years)" (elasticity of 2.56), "adult (15+) literacy rate women" (elasticity of –2.42) or Youth (15-24 years) versus "literacy rate women" (elasticity of –1.99) (Table 6, equations 7-9).

Limited knowledge, poor education, low capacity and lack of economic resources are factors inhibiting access to health and to improved drinking water as can be read from Table 6 (equations 10-11). Besides that, health vulnerability to water related sanitation problems is also shown in table 6 (equations 12-14).

Total "School Life Expectancy (in years)" and Youth (15-24) Literacy Rate "Total" are highly sensitive to improvements in wealth/poverty expressed by GDP per capita. Moreover, increases in Population Distribution in Urban area have a positive impact on education levels (Table 6, equations 15-16).

In these countries, fertility rates are higher due to lower levels of female education and activity. As shown in table 6, equation 17, fertility rate is highly sensitive to improvements in School life expectancy for women.

All the results obtained in this empirical analysis on UN are consistent with those that have been discussed earlier and attained using other databases.

3.3. Interdependencies Based on Aggregate Composite Indices

The indices used include the Human Development Index (HDI) and the Human Poverty Index (HPI) as published by the UNDP. The indicators also include the Economic Freedom Index (EFI)[4] compiled by the Heritage Foundation, the

[4] The heritage foundation, 2009 http://www.heritage.org/Index/.

Knowledge Economic Index (KEI)[5] of the World Bank Institute (WBI), in addition to other indices such as the ENV measured by the Environmental Performance Index (EPI) (2008).

At this stage of the investigation, it seems important to see how aggregated composite indices developed for the countries of the region are related. The reason for this exercise is directly linked with the fact that most indices are provided by different sources and that there is no reason to think that these indices are inter-related.

TABLE 7
Relationships between composite indices.

	R^2	N
$CPI = \underset{(-3.35)}{-4.411} + \underset{(3.099)}{1.045}\ HDI + \underset{(4.608)}{1.486}\ IEF$	0.748	17
$HDI = \underset{(-3.555)}{-2.675} - \underset{(-2.674)}{0.110}\ HPI + \underset{(3.972)}{0.334}\ ENV$	0.905	17
$ENV = \underset{(101.608)}{8.398} + \underset{(7.197)}{1.556}\ HDI$	0.799	17
$KEI = \underset{(-3.668)}{-0.374}\ HPI$	0.943	17
$HPI = \underset{(2.251)}{2.209}\ IEF - \underset{(-6.336)}{1.515}\ KEI$	0.826	17

Notes: 1. t-stat between parentheses under 1% significance level.
2. N refers to the number of countries included in the regressions.

The results in table 7 show the levels of interdependencies among these indices that are obtained from different sources, using different methods. These regressions illustrate how the CPI can be improved (reduced) with more (less) improvements (reduction) in the HDI and EFI. Also, human development is positively related to the environmental index, but negatively related to human poverty. The other relationships show how the knowledge and poverty are negatively related. The estimated levels of elasticities (coefficients) are important (1 to 2), knowing that the scales used vary from 1 to 10 for CPI and from 0 to 1 for most of the other composite indices. For example, any improvement in the openness of the economy in the region would imply less corruption and more transparency as a higher CPI indicates. Another improvement in HDI also leads to larger transparency. Improvements in the physical environment are other channels for the promotion of HDI, and then of transparency. The promotion of education reduces poverty with an increase of the HDI, and of transparency, as measured by CPI.

With the above analyzes, interdependencies have been identified among different variables. It is important though to establish directions of causality among these variables.

[5] Yale University and Columbia University, 2008 http://epi.yale.edu/Home.

3.4. Testing for Granger-Causality

The Granger-Causality test allows for the identification of causality among variables using time series data. The procedure for two variables, is based on running regression analysis on time series data for variables x and y, and their lags to get the restricted and unrestricted sum of squared residuals.

3.4.1. *Database*

There are few variables for which longer time series are available. The variables that have been selected are those of life expectancy at birth (LEB) as representative of heath. The remittances of migrants (LWR) and the share of trade in GDP (LTR) in Algeria, Egypt, Turkey and Morocco are chosen as representatives of economic variables. For education, the primary school (LPR) and secondary school enrollments (LSS) are used in Morocco only.

TABLE 8
Database used for Granger causality.

Education	Years	Countries
Primary school enrollment (LPR) Secondary school enrollment (LSR)	1991-2008	Morocco
Health		
Life expectancy at birth (LEB)	1991-2008	Algeria, Egypt, Turkey Morocco
Economics		
The remittances of migrants under logarithmic form (LWR)	1991-2008	Algeria, Egypt,
The share of trade in GDP (LTR)	1991-2008	Turkey Morocco

Note: All the variables are used under their logarithmic forms.

3.4.2. *Granger causality*

One and two lags have been used to test for Granger causality (Thornton and Batten, 1984). This is achieved through running unrestricted and restricted regressions between each two couple of variables that are found to have enough observations and that represent respectively health, economics and education. In this context, and for each couple of variables, an F-statistic test has been performed. This is to test for the null hypothesis H0 (the explanatory variable does not Granger cause the dependent variable, against HA (the explanatory variable does cause in the Granger sense, the dependent variable). The results of these tests are introduced respectively as they are summarized below under one lag and two lags, knowing that the number of observations in each annual series has been lower than 30. It is recognized that at least two limitations may affect the results. The

first one is directly related to the number of variables in the categories health, economics and education, while the second is the length of the time series.

The results achieved under the above limitations are considered respectively under 5 and 1 percent significance levels. For Algeria under two lags, trade appears to be Granger causing health, as measured by life expectancy at birth, at 5% significance level. For Egypt, under two lags, life expectancy at birth appears to be Granger causing at 5% significance level. For Turkey, life expectancy appears also to be causing the share of trade in GDP at 1% significance level under one lagged model. The most important results attained are related to Morocco where education represented by enrollment at the primary school level appears to be Granger causing life expectancy. This is confirmed for both primary and secondary enrollment when using two lagged models. Tables 9 and 10 summarize respectively the details by country and for one and two lagged tests under respectively, 5 and 1 percent levels of significance. The analysis is here limited to 5% and 1% significance levels with one and two lags as discussed in Thornton and Batten (1984).

TABLE 9
Granger Causality with One lagged Variable.

		F-Calculated	H0 5%	H0 1%
Egypt	LEB/ LWR	0.000	Accept	Accept
	LEB/LTR	0.000	Accept	Accept
	LWR/LEB	1.860	Accept	Accept
	LTR/LEB	2.865	Accept	Accept
Turkey	LEB/LWR	0.000	Accept	Accept
	LWR/LEB	7.680	Reject	Accept
Morocco	LEB/LPSS	26.000	Reject	Reject
	LEB/LSS	0.000	Accept	Accept
	LEB/LWRS	3.333	Accept	Accept
	LEB/LTR	0.000	Accept	Accept
	LPSS/LEB	0.000	Accept	Accept
	LSS/LEB	0.510	Accept	Accept
	LWR/LEB	7.780	Reject	Reject
	LTR/LEB	3.850	Accept	Accept
Algeria	LEB/LTR	0.000	Accept	Accept
	LTR/LEB	3.940	Accept	Accept

TABLE 10
Granger Causality with two lagged variables.

		F-Calculated	H0 5%	H0 1%
Egypt	LEB/LWR	3.667	Accept	Accept
	LEB/LTR	3.667	Accept	Accept
	LWR/LEB	5.923	Reject	Accept
	LTR/LEB	2.013	Accept	Accept
Turkey	LEB/LWR	12.000	Reject	Reject
	LWR/LEB	4.904	Accept	Accept
Morocco	LEB/LPSS	5.750	Reject	Accept
	LEB/LSS	5.750	Reject	Accept
	LEB/LWRS	0.000	Accept	Accept
	LEB/LTR	0.000	Accept	Accept
	LPSS/LEB	2.300	Accept	Accept
	LSS/LEB	0.632	Accept	Accept
	LWR/LEB	4.083	Accept	Accept
	LTR/LEB	1.825	Accept	Accept
Algeria	LEB/LTR	5.250	Reject	Accept
	LTR/LEB	0.053	Accept	Accept

Besides the limitations related to the length of time series, and in addition to the difficulty of the determination of causality under Granger tests, other difficulties are related to the choices and trade-offs made by individuals and households over different socio-economic components (Fukuda-Parr and Sakiko 2007; Gaertner and Wulf 2008).

4. CONCLUSION

The economic issues addressed by this research are related to the identification of interdependencies of health, education and poverty in the context of South Mediterranean countries. The determination of the directions of causality between variables is also pursued. For that, regression and principal component analyzes besides Granger causality tests are the main techniques applied to different datasets. The first set of data is that of World Bank. The second is the most recent

database of the United Nations. The third set is based on the international composite indices as they have been provided for the countries included in this study, by different international organizations.

The overall results attained at every level of the analysis show the high magnitude of interdependencies between all sets of variables related to health, education and wealth/poverty.

The empirical analysis demonstrates the existence of a strong positive relationship between GDP and the number of physicians per 1,000 population. The improvements (decreases) in GDP are likely to generate better (lower) health conditions for both mothers and children in this region. While the number of physicians is positively related to GDP, any reduction (enhancement) through other mechanisms (brain drain for example) increases (decreases) the mortality rate.

The level of enrollment in primary school appears to be under the effect of both health and wealth variables. Poverty and bad health negatively affect the level of enrollment in primary school. Generally the level of education is highly sensitive to improvements in wealth/poverty. Moreover, increases in Population Distribution in Urban area have a positive impact on education levels.

Similarly, infant mortality rate is sensitive to both income and education. The levels of unemployment do affect infant mortality. Moreover, the general level of population health is affected by income/poverty, unemployment and education.

Health and education appear to have an important driving effect on these interdependencies as shown by Granger causality tests. The representative variables of health, education and poverty seem to entertain higher levels of interdependencies, implying that any change in one of the variables, significantly affects the others. This is also confirmed through the analysis of composite indices where clear relationships have been estimated.

These results show that these interdependencies are to be considered in economic and social policies and that further transversal and integrated human development policies can generate higher outcomes to the region. Furthermore, emphasis on health and education is likely to create higher social and economic benefits.

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