

Measuring Poverty/Health: A Cautionary Note

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Abstract

Economists use various measures to account for the affect of poverty, welfare or health on economic growth but there is a lack of understanding of the movement of such variables over time and whether countries experiences similar trends. This paper presents an analysis of life expectancy across Africa and the Middle East and identifies trends that can be clustered in experience, although a convergence in experience appears prominent. The statistical analysis is repeated for fertility, GNP and mortality rates but we find there is no guarantee that countries will experience similar experiences across these measures.

JEL Classification: C40; O11

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1. Introduction

Even though poverty indicators such as life expectancy, fertility, GNP and mortality rates are frequently used as regressors in economic models to account for the effect of health and welfare on economic growth, there is a scarcity of detail on the evolutionary paths of poverty indicators *per se*. Population studies do present some insights: for instance, Sardon (2002) examined fertility trends across developed countries and identified some countries that encountered downward trends while others experienced clear recoveries; this is in spite of an almost universal decrease in completed fertility. Meslé and Vallin (2002) identify a divergence in the trends of mortality rates across European countries between 1965 and 1995; countries in the south, west and north experienced improvements in mortality rates of about 6 years over this period while countries in the east experienced an improvement in mortality rates of only about 1 year.

The omission of an in-depth analysis of trends in poverty indicators in the economics literature is surprising for three reasons. First, given the focus on poverty alleviation in less developed countries at the 2005 G8 summit in Glen Eagles, Scotland, and the amount of aid that is given to some countries that suffer from very low levels of welfare (defined in various ways). Second, some variables, such as life expectancy, are been identified as having some asymptotic limiting value to which cross-country trends may well converge, although this omission in the literature might be because such limits are often broken (Oeppen and Vaupel, 2002). Third, different authors employ different variables to control for the effect of poverty/health on economic growth and yet they interpret the economic effect on economic growth of changes in these variables in very similar ways; for instance, Knowles and Owen (1995) use life expectancy to capture the effect of health on economic growth, while Webber (2002) uses the extent of under-nutrition to do the same. These inconsistencies in the literature and the lack of understanding of how poverty/health related variables are trended

and correlated across countries could be one reason why the effect of health on economic growth is often disputed.¹

An initial assumption for development economists can be that trends in poverty indicators (such as life expectancy, fertility, GNP and mortality rates) are strongly correlated. This paper investigates whether there are similarities in trends in poverty indicators across countries for life expectancy, fertility, GNP and mortality rates in Africa and the Middle East. Multiple regression techniques are used to model broad trends in poverty indices over time and the information extracted from the regression analyses are used as inputs into a hierarchical clustering algorithm in an attempt to identify groups of countries with similar and dissimilar evolving poverty profiles. Section 2 presents the method for analysis. Section 3 presents the results and Section 4 summarises the conclusions.

2. Analysis of the Poverty Indices

Time series analysis typically requires actual data but observations for a variable such as life expectancy are only available from a census and at best every ten years. Instead we employ a method that considers observations at ten year intervals. To investigate similarity in poverty indices between pairs of countries over time regression models of the form:

$$P_i = \alpha + \beta_1 T_i + \beta_2 Z_i + \beta_3 T_i Z_i + \varepsilon_i \quad (1)$$

may be considered where, P_i is the poverty index under consideration, T denotes time (year), Z is a country specific dummy variable, and ε is the error term (assumed to be independent

¹ For example, using life expectancy as their health related measure, Knowles and Owen (1995, p. 99) find “a stronger and more robust relationship between income per capita and health capital, than between income per capita and educational human capital” while Webber (2002) finds the opposite using the extent of under-nutrition as his health proxy.

and normally distributed). The important variable here is $T_i Z_i$, which is included to capture interaction effects between time and country (i.e. whether the rates of change of the poverty index over time are different between country A and country B). The model can determine whether the rate of change of the poverty index for the two countries are in opposite directions. This last condition occurs if, and only if,

$$\beta_1 > 0 \quad \text{and} \quad (\beta_1 + \beta_3) < 0 \quad (2)$$

or if

$$\beta_1 < 0 \quad \text{and} \quad (\beta_1 + \beta_3) > 0 . \quad (3)$$

If the interaction term in (1) is statistically significant and if either (2) or (3) hold, then the two countries involved show divergent behaviour on the poverty index over time.

Model (1) can be estimated for all possible pairs of economies in a sample and in each instance the pair is coded '1' if divergent and '0' otherwise. For N economies the codes '1' and '0' may be stored in an N by N square symmetric matrix \mathbf{A} , with elements $a_{ij} = 1$ if countries i and j diverge on poverty index P , and $a_{ij} = 0$ otherwise. This profile of a divergent-behaviour-matrix may then be used as the input into a clustering technique. In what follows agglomerative hierarchical clustering using Wards method (Ward, 1963) on the Manhattan distance between the profiles of the countries has been used to fuse clusters.

If there are consistent trends in poverty indicators within groups of countries (e.g. a group of countries showing improvements in aspects of poverty) then a high degree of homogeneity of clusters is anticipated. In the absence of such consistency, clusters of countries formed on one

poverty index may have very different club membership when clustered on a different poverty index.

3. Results

Data were not always available for all variables and for all countries over all time periods.. Nevertheless this data attrition problem should not affect the results substantially. In what follows the methods discussed in Section 2 above are applied to four important variables that capture aspects of poverty/health; these are life expectancy, fertility, GNP and mortality rates respectively. In each case, two groups of countries are identified; group A is always the main group as it is comprised of the greatest amount of countries while group B is the group of countries that is moving at a different rate over time.

3.1 Life Expectancy

Application of (1) resulted in the identification of 23 pairs of countries showing divergent life expectancy rate relationships with 39 countries showing an upward trend in life expectancy rate over time. Figure 1 shows the dendrogram for clustering the profiles of divergent behaviour for life expectancy.

These results suggest there are two distinct groups of countries within which there is convergence. From the observation of the raw data, we can identify that there is no evidence of stagnation or falls in life expectancy that was identified by Vallin and Meslé (2004) for some developed countries and by Janssen *et al.* (2004) for European countries. Instead, two distinct groups of countries are identified which are converging in experience.

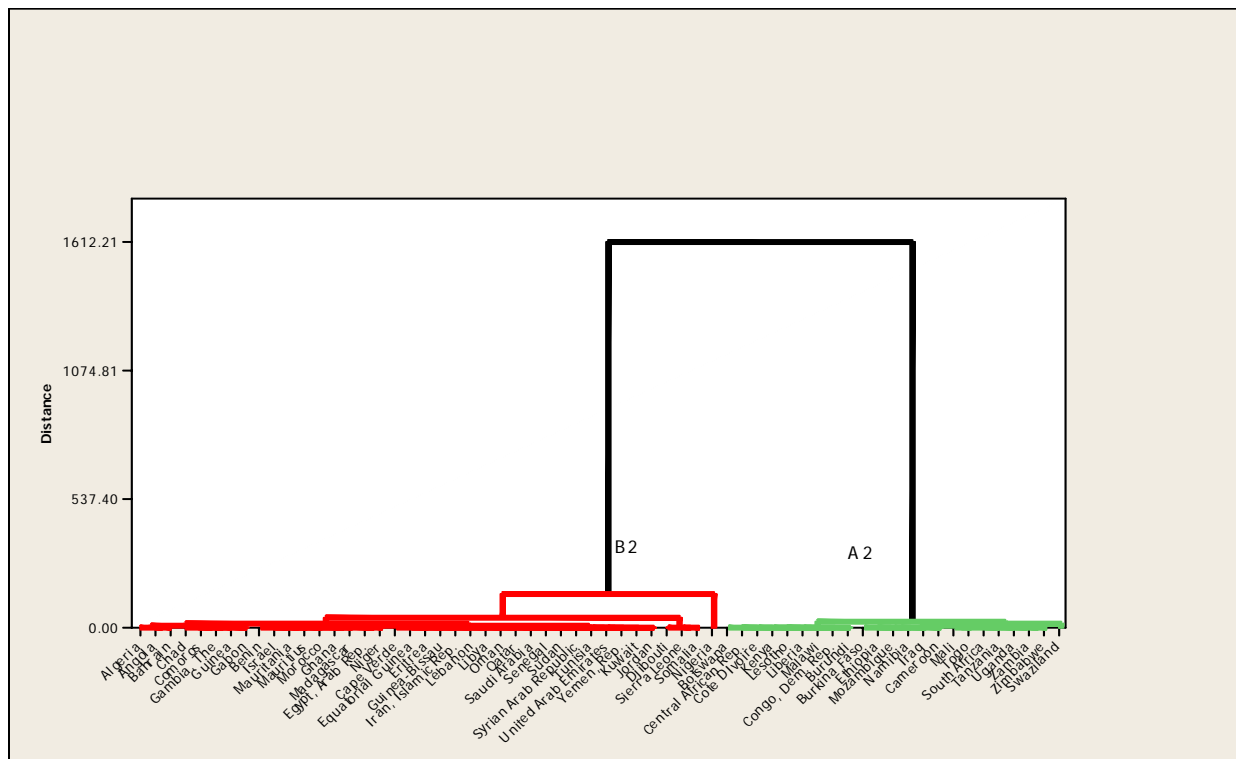


Figure 1: Life Expectancy.

3.2 Fertility (A)

To identify whether the trends for fertility are similar to life expectancy, fertility data are regressed on T to reflect the amount of change in fertility that can be expected to accompany a change of one unit in a year. Sardon (2002) found asymmetries in the experience of fertility trends across *developed* countries; some were downward trends while others were clear recoveries; this was in spite of an almost universal decrease in completed fertility. To identify whether these types of experiences are shared by less developed countries in Africa and the Middle East, data on fertility rates are regressed on T to reflect the amount of change in fertility that can be expected to accompany a change of one unit in a year. Application of (1) resulted in the identification of 120 pairs of countries showing an upward trend in fertility over time and with only four countries (Angola, Chad, Gabon and Equatorial Guinea) showing fertility rate relationships that are divergent from the main group.

Figure 2 presents the dendrogram for clustering the profiles of divergent behaviour for fertility rates. Inspection of the dendrogram reveals two clearly defined clusters with the smaller cluster comprising Angola, Chad, Equatorial Guinea and Gabon, as anticipated from the regression analyses. These two distinct groups of countries are encountering a convergence of experience; with group A1 showing an improvement in fertility rate over time and group B1 which has a distinctly slower rate of improvement in fertility rates. There are clusters of countries that experience different trends in fertility rates over time, which is in line with the results presented by Sardon (2002) for developed countries.

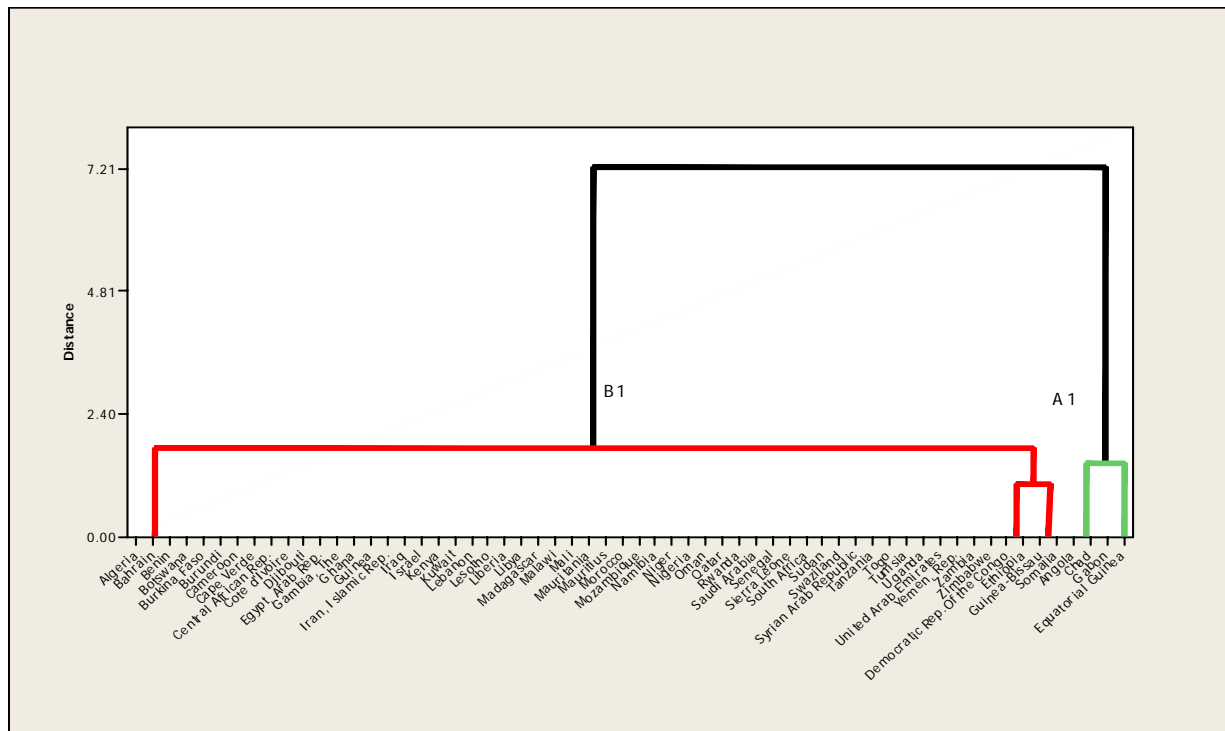


Figure 2: Fertility Rate.

3.3 Gross National Product

To identify the trends for GNP, GNP data are regressed on T to reflect the amount of change in GNP that can be expected to accompany a change of one unit in a year. This time 4 pairs

of countries were identified showing divergent GNP relationships. Figure 3 shows the dendrogram that clusters the profiles for GNP over time.

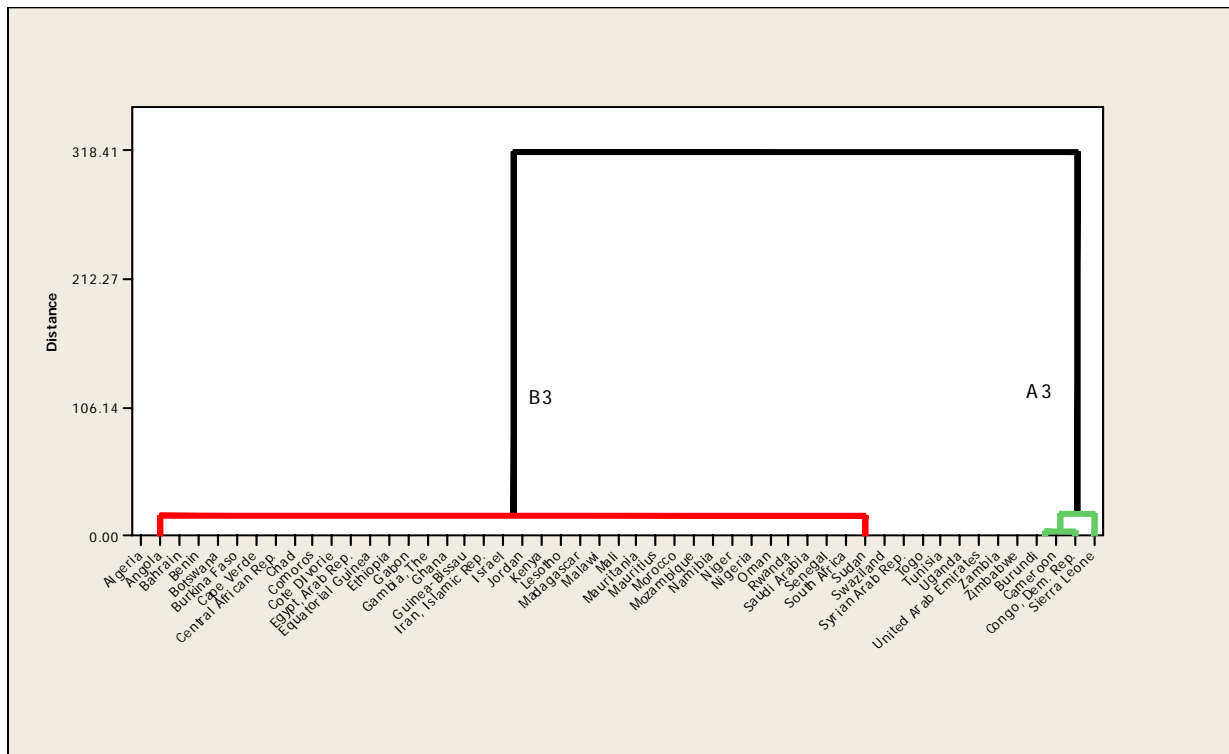


Figure 3: GNP

Out of all the poverty/health trends analysed in this paper, GNP seems to show that most countries are following a similar pattern, as the majority of the countries appear to be converging in experience over time; there are only a few countries that appear to be following a different trend (group C2, which is comprised of Burundi, Cameroon, Congo and Sierra Leone) from the main group (group C1). Note that these are not the same four countries that were identified as being in a divergent group for the fertility variable.

3.4 Mortality Rates

Data for mortality rates are regressed on T to reflect the amount of change in mortality rates that can be expected to accompany a change of one unit in a year. Application of (1) resulted

in the identification of 53 pairs of countries showing divergent mortality rate relationships. Figure 4 shows the dendrogram for clustering the profiles of divergent behaviour for mortality rates.

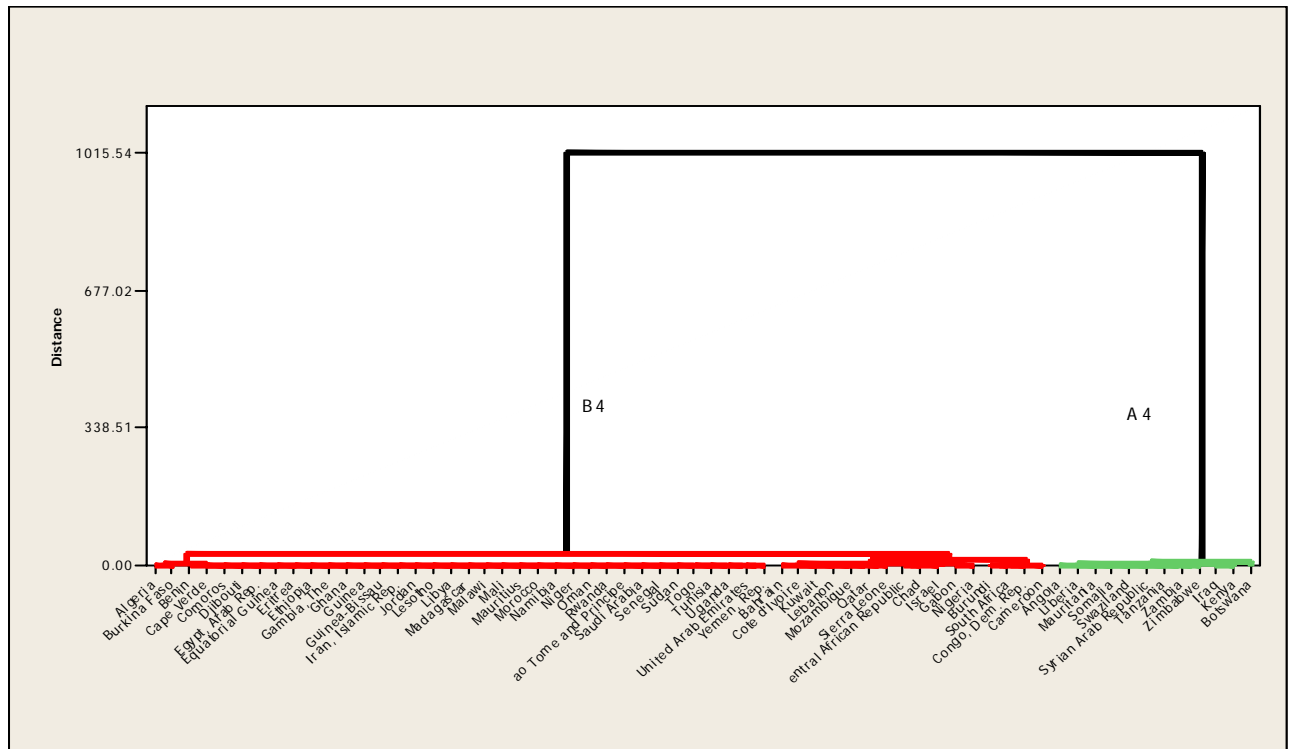


Figure 4: Mortality Rate

Two distinct groups of countries are encountering a convergence of experience. This divergence in experience is not unexpected as it is also happening for some of the most developed countries; the US and Japan appear to have also diverged in their trends in mortality rates (Barbi, 2005).

4. Discussion

Table 1 presents the list of countries that experience divergent trends for each poverty related indicator. There are no countries that appear in the divergent groups three times. A few

Table 1: Countries in a cluster that is moving away from the main group

Variable	Fertility Rate	Life Expectancy	GNP	Mortality Rate
<p>Group A</p> <p><i>(Showing improvement)</i></p>	Algeria	Algeria	Algeria	Algeria
	Bahrain	Angola	Angola	Bahrain
	Benin	Bahrain	Bahrain	Benin
	Botswana	Benin	Benin	Burkina Faso
	Burkina Faso	Cape Verde	Botswana	Burundi
	Burundi	Chad	Burkina Faso	Cameroon
	Cameroon	Comoros	Burundi	Cape Verde
	Cape Verde	Djibouti	Cape Verde	Central African Republic
	Central African Republic	Egypt	Central African Republic	Chad
	Congo	Equatorial Guinea	Chad	Comoros
	Djibouti	Eritrea	Comoros	Congo
	Egypt	Gabon	Egypt	Djibouti
	Ethiopia	Gambia	Equatorial Guinea	Egypt
	Gambia	Ghana	Ethiopia	Equatorial Guinea
	Ghana	Guinea	Gabon	Eritrea
	Guinea	Guinea-Bissau	Gambia	Ethiopia
	Guinea-Bissau	Iran	Ghana	Gabon
	Iran	Israel	Guinea-Bissau	Gambia
	Iraq	Jordan	Iran	Ghana
	Israel	Kuwait	Israel	Guinea-Bissau
	Ivory Coast	Lebanon	Ivory Coast	Iran
	Kenya	Libya	Jordan	Israel
	Kuwait	Madagascar	Kenya	Ivory Coast
	Lebanon	Mauritania	Lesotho	Jordan
	Lesotho	Mauritius	Madagascar	Kuwait
	Libya	Morocco	Malawi	Lebanon
	Madagascar	Niger	Mali	Lesotho
	Malawi	Nigeria	Mauritania	Libya
	Mali	Oman	Mauritius	Madagascar
	Mauritania	Qatar	Morocco	Malawi
	Morocco	Saudi Arabia	Mozambique	Mauritius
	Mozambique	Senegal	Namibia	Morocco
	Namibia	Sierra Leone	Niger	Mozambique
	Niger	Somalia	Nigeria	Namibia
	Nigeria	Sudan	Oman	Niger
	Oman	Syria	Rwanda	Nigeria
	Rwanda	Tunisia	Saudi Arabia	Oman
	Saudi Arabia	UAE	Senegal	Qatar
	Senegal	Yemen	South Africa	Rwanda
	Sierra Leone		Sudan	Saõ Tome and Principe
	Somalia		Swaziland	Saudi Arabia
	South Africa		Syria	Senegal
	Sudan		Togo	Sierra Leone
	Swaziland		Tunisia	South Africa
	Syria		Uganda	Sudan
	Tanzania		UAE	Togo
	Togo		Zambia	Tunisia
	Tunisia		Zimbabwe	Uganda
	Uganda			UAE
	UAE			Yemen
	Yemen			
	Zambia			
Zimbabwe				
<p>Group B</p> <p><i>(Showing less improvement that Group A)</i></p>	Angola	Botswana	Burundi	Angola
	Chad	Burkina Faso	Cameroon	Botswana
	Equatorial Guinea	Burundi	Congo Dem. Rep.	Iraq
	Gabon	Central African Republic	Sierra Leone	Kenya
		Cameroon		Liberia
		Central African Republic		Mauritania
		Congo Dem. Rep.		Somalia
		Ethiopia		Swaziland
		Iraq		Syria
		Ivory Coast		Tanzania
		Kenya		Zambia
		Lesotho		Zimbabwe
		Liberia		
		Malawi		
		Mali		
		Mozambique		
		Namibia		
	South Africa			
	Swaziland			
	Tanzania			
	Togo			
	Uganda			
	Zambia			
	Zimbabwe			

Notes: Countries in **bold** type appear in two splinter group categories.

countries appear twice in the divergent groups, these being Angola, Botswana, Cameroon, Congo Dep. Rep., Kenya, Liberia, Swaziland, Tanzania, Zambia and Zimbabwe.

Taking the analytical results together, two important points are made. First, countries can be clustered in their evolutionary experience for different health related variables. Second, there are countries that do not follow the same evolutionary experience for important poverty/health related variables. Third, if a country follows the 'standard experience' for one poverty/health related variable it doesn't necessarily imply that they will follow the same evolutionary experience for other poverty/health related variables.

As different economists employ different poverty/health related variables when attempting to capture the effect of poverty/health on economic growth, care needs to be taken when interpreting results, identifying of controversies and consistencies and when formulating policy.

5. Conclusion

The purpose of this paper was to investigate whether similarities in trends in poverty indicators exist for life expectancy, fertility, GNP and mortality rates across African and Middle Eastern countries. Regression techniques were employed to identify broad trends in poverty indices over time. Information was extracted from the regression results and used as inputs into a hierarchical clustering algorithm. The results presented suggest that there are countries that follow an evolutionary path for one variable that is similar to most other countries but will follow evolutionary paths for other variables that are different from the norm.

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Appendix:

Poverty Index Definitions

- *Fertility rate, total (births per woman)*: The average number of births a woman could expect to have during her lifetime if she followed observed levels of fertility from her age group at every age. The TFR (total fertility rate) is calculated as the sum of average annual age-specific fertility rate for all reproductive age groups (usually at least 13 and at most 50 years old). Observations were employed that correspond to the 1970, 1972, 1975, 1977, 1980, 1982, 1985, 1987, 1990, 1992, 1995, 1997, 2000 and 2001. Source: World Bank's World Development Report (Various issues).
- *Life expectancy at birth (in years)*: Life expectancy is the average number of years a newborn infant would be expected to live if health and living conditions at the time of birth remained the same throughout. High life expectancy at birth suggests that people have access to the things that contribute to a long, healthy life such as nutritious food, safe water, sanitation, health care and education. Observations employed correspond to 1980, 1982, 1985, 1987, 1990, 1992, 1997, 2000 and 2001. Source: World Bank's World Development Report (Various issues).
- *GNP (current international, \$)*: Gross National Product per capita is the dollar value a country's final output of goods and services in a year (its GNP) divided by its population. It reflects the average income of a country's citizens. Knowing a country's GNP per capita is a good first step towards understanding the country's economic strengths and needs. Countries with low GNP per capita tend to be located in Sub-Saharan Africa and parts of Asia. Countries with high GNP per capita tend to be located in Europe, North America and parts of Asia. Source: World Bank's World Development Report (Various issues).
- *Mortality rate, infant (per 1,000 live births)*: The number of deaths to children under 12 months of age per 1,000 live births. Source: World Bank's World Development Report (Various issues).