ISSN: 2993-8732

DOI: 10.33552/IJEBM.2023.01.000507

Iris Journal of
Economics & Business Management

Iris Publishers

Research Article

Nexus of Economic Growth and Levels of Education in Algeria: An Empirical Study Using the Principal Component Analysis (PCA)

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Received Date: May 25, 2023

Published Date: June 14, 2023

Abstract

The general objective of this paper is to assess the contribution of the different levels education for economic growth in Algeria during the period 1980-2022. To do this, we first rely on a so-called endogenous growth model: the Solow model "Augmented" by the human capital developed by Mankiw, Romer and Weil (1992). Then, we use the assessments of [5] which generate the average number of years of study of the economically active population for the different levels of education. And finally, we build from the Principal Component Analysis (PCA), an indicator composite of human capital to integrate aspects of our empirical model qualitative education alongside the quantitative proxy that is the average number of years of study indeed, our estimates reveal that only the level of primary education has an effect significant in addition, taking into account the quality of education improves our results and allows to assess at 24% the contribution of the primary level to Algerian economic growth.

JEL classification: E13; I21; O40

Keywords: Stock of education; PCA; Economic growth; Algeria

Introduction

Education has become a major issue in today's economies because it is recognized that it constitutes an effective means to amplify economic growth through training, the creation of new skills, know-how and skills. Indeed, the fight against poverty, the increase in productivity and individual income and then that of the economy of a country go through the implementation of effective education systems [10]. This is why, we see that in recent decades, the educational policy has taken off in all countries of the world and particularly in sub-Saharan Africa (Sow, 2013). Moreover, it emerges from the 2011 edition of the Education For All Global Monitoring Report (EFA) that education spending has increased (in% of GDP), rising from 2.9 in 1999 to 3.8 in 2011 in low-income countries. Particularly in Algeria in recent years have been marked by a greater allocation of resources to education policies in order to achieve the objective of universal schooling through primary education for all by 2015. Total public expenditure in the education sector (in% of GDP) rose from 2.11 to 4.90 over a period from 1970 to 20122. This has resulted in a considerable increase in demand for education with high enrollment rates at all levels and more education important with establishment with establishments at all levels of education. At the same time, the country's economic situation has improved steadily from 2007 to the present day. Indeed, in 2007 the growth rate of the gross domestic product, which was only 2.3% rose to 5.6% in 2012 thus characterizing a period of economic recovery. So, the statistics mentioned so far show us clearly that in Algeria, the envelope of the national budget allocated to education on the one hand and the evolution of the growth of the GDP on the oth-

er hand, visibly display a joint increase during these last years. So, starting from the assumption that a country's investments must be directed towards the most profitable sectors in terms of economic and social development, we want to quantify the contribution of different levels of education to economic growth in Algeria based on an endogenous growth model.

Literature Review

This section presents the literature review on the relationship between education and growth, drawing mainly on quantitative and qualitative analyzes of this relationship. Indeed, the idea that education contributes to growth is both the origin and the outcome of the theory of human capital whose founders are Schultz (1961), Mincer (1964) [6]. For these theorists, education accounts for most of total productivity factors, and since the early 1980s there have been many studies tend to confirm this positive role of growth education. We let's first talk about the results of the classics of this literature, [4] Mankiw, Romer and Weil (1992). In cross section on a hundred countries (including those of the OECD), these measure the effect of education on growth in GDP per capita between 1960 and 1985. The authors measure education by gross enrollment rates. But Barro distinguishes education primary and secondary while Mankiw, Romer and Weil use an average over the period of the gross secondary education rate compared to the population active. Both result in a positive and significant effect of education on growth. African Integration and Development Review Volume 8, 2015 educational levels and economic growth in Algeria 4. In this continuity, Mauro (2000) studies the effect of education in terms of stock on the development of Italian regions over the past thirty years. By testing different models, including those of Islam (1995) and Barro and al. (1997), and by neutralizing unemployment rates and work experience accumulated, Mauro observes a positive and significant relationship between education and long-term growth. These conclusions are shared by Sow, A. (2013) who indirectly tests the effect and the effectiveness of education on the productivity of Senegalese companies. The result of this test found that education has a positive effect on Senegal's economic growth, through the positive impact of the levels studies of the manager and the employee on productivity. This result corroborates with those of [8], who, considering a panel of 19 countries from Sub-Saharan Africa through the approach of borders, find a positive impact of the overall stock of human capital on the growth of the productivity. In a study, Quenum (2011) which, using the so-called growth models endogenous and data from all eight (08) WAEMU countries on the period 1970 - 2005, arrives at estimates which show that for the countries poor, primary education has a positive effect on growth, while the secondary and tertiary have no significant effect with sometimes even negative coefficients. Indeed, it is recognized that these are the problems of quality of education or human capital skill area which may explain these unexpected effects. For our part, it remains to analyze the specific case of Algeria using the available data in order to be able to grasp the depth of the economic reality of this country in relation to the contribution of education to its growth. The various works mentioned are not exhaustive, because many others research like that of Psacharopoulos and Patrinos (2002), Foko and Brossard (2007) and Nomenyo (2011) confirm the positive effect of education on Economic Growth. However, by the early 1990s, optimism about the positive role of education in economic growth has blunted a little with results of other studies. [7] ask the question next: How is the education level of the affected workforce the production and growth of an economy? Indeed, they could not find the positive relationship described by Mankiw et al. (1992) between capital human and economic growth using the standard approach (that of Mankiw Romer and Weil) which involves processing human capital, measured through the average number of years of labor force study as a factor African Integration and Development Review Volume 8, 2015 Educational levels and economic growth in Algeria ordinary production. [7] who were the first authors question the role of education in economic growth, propose an alternative approach associated with the theory of growth endogenous, which consists of modeling technological progress, or the growth of overall factor productivity as a level production function education or human capital the maximum controversy will come from the empirical studies of Prtichett (2001). He uses the stock data collected by Barro and Lee (1993), de Nehru et al, (1995) and Psacharopoulos (1993) on a large number of countries (91 in total) and over a period from 1960 to 1987. The dependent variable being the rate of GDP growth per worker from the "Penn World Table 1" database, the the results of the estimates are quite surprising. Estimating the impact of the growth of educational capital on the growth rate of income per worker is negative and not significant. A similar result is found when the study is applied to the MENA3 region in cross section. These results deemed "binding" led him to wonder: where did education go? So, for Pritchett (2001), this weak or sometimes non-existent link can be explained essentially by three factors: first, education does not increase capital human but increases private wages, and marginal returns to education is declining rapidly (Psacharopoulos and Patrinos, 2004). Then, the prevailing institutional environment in many countries does not favor the accumulation of human capital already concentrated in annuity activities which stifle economic growth. Finally, the quality of education can be so weak that it lacks the skills required to achieve a economic growth. In the same vein, Islam (1995) implements more complex panel methods. He considers an intermediate form in which human capital is measured directly in stock while capita physics is introduced through the investment rate. The results of this suggest that reversing conclusions is less the result of change of model (equilibrium method versus production function) only taking into account fixed effects by the second generation of estimates. The results of this estimate are close to those of Pritchett, since we led to assume a negative relationship of growth education and in a significant way. So, when the most robust econometric methods are used, it becomes impossible to show a positive relationship between capitals.

Against this backdrop, we examine the impact of remittances on economic growth in Cameroon by bringing out the pronounced positive effect of remittances on economic growth as compared to other external sources of capital. To this end, we employed an econometric procedure as the recently ARDL bounds testing approach which heavily relies on Multivariate Cointegration within an

error correction model (ECM) to establish both the short- and long-run relationships between inflows of remittances, and other external inflows in the form of foreign aid, foreign direct investment and openness to trade on economic growth for the period 1960 to 2014.

Methodology

The reference model is inspired by that of Solow increased by human capital developed by Mankiw, Romer and Weil (1992). Indeed, we present first the functional form of the model and the main stages leading to the empirical model, before secondly specifying the model that we used for our empirical analyzes. From a function of Cobb-Douglas type production, the model is as follows.

$$y_t = \left(A_t L_t\right)^{1-\alpha-\beta} K_t^{\alpha} H_t^{\beta} \quad (1)$$

With y_t the production at date t, K_t the stock of physical capital, H_t the stock

of human capital, L_t that of work and at the technological level (neutral to sense of Harrod, which helps generate a stationary equilibrium in a competitive economy) are:

$$y_t = \frac{Y_t}{A_t L_t}, \quad k_t = \frac{K_t}{A_t L_t}, \quad h_t = \frac{H_t}{A_t L_t}$$

The variables y_t, k_t and h_t, respectively denote income, physical capital and human capital per unit of efficient work at date t. Equation (1) can then write: $y_t = k_t^{\alpha} h_t^{\beta}$

Assuming that s_t is the fraction of the income invested in physical capital and

s_h that invested in human capital, the dynamics of accumulation of factors is determined by:

$$\dot{k}_t = s_k . y_t - (n+g+\delta)k_t$$

$$\dot{h}_t = s_k . y_t - (n+g+\delta)h_t \quad (2)$$

With $\dot{k}_t$ is the rate of accumulation of physical and $\dot{h}_t$ is capital, that of capital human, n the growth rate of the (active) population, g that of the technology and δ the rate of depreciation of capital (physical and human)

in the event that (i.e., when $\alpha+\beta<1$ the technical production is decreasing and returns only in the factors of K and H), the level of physical and human capital by efficient work in the steady state is given by.

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}}; \quad h^* = \left(\frac{s_{\alpha}^{1-\alpha} s_h^{\alpha}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \quad (3)$$

By substituting these values in the production function and taking the logarithm, we get the long-term equilibrium equation of per capita income next:

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln A + g - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h \quad (4)$$

This equation shows how per capita income depends negatively on population growth rate and positively the accumulation of physical and human capital. Another way to reveal the role of human capital is to express the previous equation (4) as a function of the level of stationary state human capital.

$\ln s_h$

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln A + g - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha}\ln s_k + \frac{\alpha}{1-\alpha}\ln s_h \quad (5)$$

empirical depends, among other things, on the availability of data allowing approximate either the rate of human capital accumulation s_h or the level of human capital per capita (h). Islam (1995) suggests for example using directly the stock of human capital in the convergence equation conditional. [11] argues that using the convergence model or that of the production function directly produces results of converging estimates. On the other hand, when we make the assumption that, $\alpha+\beta=1$ (K and H have a constant yield), we end up with a function endogenous growth. It's this type of functional relationship that is often used to empirically test growth patterns; but with the additional assumption that the economies in question have reached their stationary equilibrium or are close to their stationary state and deviate from it that randomly. The speed of convergence towards the level of income by stationary equilibrium is given by

$\frac{d \ln y_t}{d_t} = \frac{\dot{y}_t}{y} = \ln\left[\ln\left(y_t\right)\right]$ with y^* is equilibrium value of y

This differential equation can deduce the following dynamic relation.

$$\ln y = \left(1-e^{-\lambda t}\right)\ln(y^*) + e^{-\lambda t}\ln y_0 \quad (6)$$

Where t measures the time and y_0 is the income per effective unit of work at the initial period using per capita income and replacing y^* with parameters of equilibrium, we obtain in structural form and in reduced form:

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln A_t + \left(1-e^{-\lambda t}\right)\left(\alpha \ln k + \beta \ln h\right) + e^{-\lambda t}\ln y_0$$

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln A_t + \left(1-e^{-\lambda t}\right)\frac{\alpha}{1-\alpha-\beta}\ln\left(s_k\right) + \frac{\beta}{1-\alpha-\beta}\ln s_h - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + e^{-\lambda}\ln y_0$$

(7)

By subtracting $\ln y_{t-1}$ ln from each member of equation (7), the transitional phase of growth an economy towards its long-term equilibrium

can then be written as follows

$$\ln y_t - \ln y_{t-1} = \ln A_t + \left(1-e^{-\lambda t}\right)\frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) - \left(1-e^{-\lambda t}\right)\ln y_{t-1}$$

(8)

To assess the contribution of human capital to growth, this

latter specification (8) has the advantage of not requiring that the economy studied be on their balanced growth path. The growth rate of GDP per capita therefore depends here on the initial position of the economy (convergence effect) and on the variables defining the long-term equilibrium towards which it converges. According to this relation (8), the rate of growth of GDP per capita is also a function of the rate of investment in physical capital, the sum of the rate of population growth, the rate of depreciation of physical capital and the rate growth of technical progress. Long-term income is also function of human capital.

In our work, we were inspired by the endogenous growth model of Solow, presented above to define that of our analysis. Indeed, we specify a model with two (2) equations: the first (9) takes into account the stock of global human capital while the second (10) separately integrates the different stocks of human capital by level of education. In addition, we have chosen to integrate the qualitative aspects of human capital (Boccanfuso, D., Savard, L. and Savy, B., 2009). To do this, we carried out a Principal Component Analysis (PCA) based on different qualitative indicators such as: the pupil per teacher ratio, public education expenditure, public expenditure per pupil, etc. in order to determine a composite indicator of human capital SH^{PCA} which once constructed, will be introduced into each of the equations alongside the usual proxy of the stock of human capital, the average number of years of study that does not appreciate than the quantitative aspect. So, the equations are as follows:

$$GDPH_t = \alpha_0 + \alpha_1 SH_t + \alpha_2 SH_t^{PCA} + \alpha_3 DUM_t + \sum_{j=1}^{k} \theta_j X_t + \varepsilon_t \quad (9)$$

$$GDPH_t = \delta_0 + \delta_1 SH_{1.t} + \delta_2 SH_{2.t} + \delta_3 SH_{3.t} + \delta_4 SH^{PCA}{}_t \delta_5 DUM_t \sum_{j=1}^{k} \theta_j X_t + \varepsilon_t \quad (10)$$

From equation (9) to equation (10) and from left to right, are labeled: GDPH: GDP per capita, this is the explanatory variable of the model.

SH: the stock of global human capital. It is clear in the immediate that SH_i or i=1;2;3 future that the primary, secondary and higher education stocks represent, respectively. They are measured by the average number of years of study by level of education contained in the database of [5]. It is further assumed that $\alpha_1 > 0 \delta_1 > 0 \delta_2 > 0 \delta_3 > 0$ because in the theory, human capital is supposed to have a positive impact on economic growth Barro and Sala-I-Martin, 1995; [5,7] SH^{PCA} the (composite) quality of education indicator. It allows to take into account the qualitative aspects of the education system. through the application of Principal Component Analysis (PCA). We agree that $\alpha_2 > 0 \quad \delta_4 > 0$ Indeed, for authors like Barro and Lee (1997), Barro (2001), [21,2], the quality of schooling is more important than quantity DUM: (dummy variable) which takes the values 1 for strike years and 0 for years without strike; X: represents a vector of variables specific to a growth equation and found in the standard growth model these variables are investment in physical capital, openness to trade, inflation life expectancy, etc. Indeed, we limit their number to better appreciate the influence of our variables of interest (those of human capital) especially for economic growth finally ε_t and ω_t are errors from years t.

The aim was to generate a synthetic measure representative of the five quality parameters of educational human capital noted SH_t^{PCA} it is obtained by the linear combination of the different indicators with respective weights. It is therefore determined by the relation (11) which is as follows:

$$SH_t^{PCA} = \sum_{j=1}^{k} \alpha_j \left(\frac{X_{j.t} - E\left(X_j\right)}{\delta_{Xj}} \right) \quad (11)$$

SH_t^{PCA} corresponds to the series of composite scores or to the series of human capital indicators, obtained by linear combination of the different k initial indicators $X_{j.t}$ are centered and reduced then weighted by the eigenvector coefficients α_j (the coordinates of the principal component) $E\left(X_j\right)$ and δ_{Xj} represent respectively the mean and the standard deviation of X_j

Data Of Study

For more than two decades, the Algerian education system has experienced enormous difficulties arising from the socio-political crises of the 1990s which led to the suspension of international cooperation. The suspension of aid has had the effect of weakening the state's institutional capacity, hampering the provision of education services and eroding the quality of basic public infrastructure. Nevertheless, despite this unfavorable macroeconomic context, the Government has always endeavored to guarantee budgetary arbitrations favorable to the education sector. At the beginning of the 2000s, the country embarked on an effort to analyze, modernize and restructure its education system by placing its action within the framework of achieving the objectives of the Dakar World Forum (2000) as well as objectives adopted by the United Nations Millennium Declaration (MDG, 2000).

This is how the Algerian education system was the subject of a first sectoral diagnosis in 2002. Improved updates of this first version were carried out in 2007. On the basis of this analytical work, and thanks to the political stability regained and upon the return of cooperation with its main donors in 2008, Algeria adopted in 2009, a letter of declaration of sectoral education policy defining new directions and options for government policy, particularly in the areas of access to school, quality of learning, piloting and management of the system. The process of preparing and implementing the national strategy for the education sector therefore took place in a context that had become much more favorable thanks to a return to economic growth, a substantial reduction in public debt as well as '' resumption of dialogue with the main donors (PSE, 2014) .In these conditions, the analyzes show a positive and significant change in school coverage throughout the education system, a sign that quantitative progress has been made during in recent years in terms of education. Indeed, between 2018 and 2019 primary, middle and secondary between 2018 and 2019 (Table 1). These data rank above the average for countries with a comparable level of economic development. With regard to the education sector, the State gives it priority budgetary. Indeed, the increase in total public resources has led to an increase in public spending on the education sector.

Table 1: The main aggregates for the 2018-2019 school year.

Educational level	Pupils		Teachers		Establishments
	Total	Including girls	Total	Including women	
Pres-school	495481	241965	17791	14861	19037
Primary	4513749	2159423	199850	162518	
Middle	2979737	1428693	159065	114638	5512
Secondary	1222673	670240	102279	67152	2433
TOTAL	9211640	4500321	478985	359169	26982

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Results and Discussion

Main results of the Principal Component Analysis (PCA)

Principal component analysis is a descriptive technique multi-dimensional to study the relationships between quantitative variables without a priori considering any structure, no variables or individuals. So, it's a mathematical method of analysis data which consists in looking for the directions of the space which represents the the better the correlations between n random variables. Whatever the matrix of correlation, there is always a PCA solution that maximizes the variance explained (Kouani et al., 2007; Duquenne, 2012). She permits also to synthesize a dataset by identifying redundancy in this one. this method is used in this study to build a synthetic indicator of human capital based on five variables quantitative: the pupil- ratio in primary education (PPEE), -expenditure education in% of GDP per capita (EEP), the number of teachers trained for primary compared to total teachers (NTP), expenditure per pupil in primary education (EPPE) and finally public expenditure per pupil in secondary (PEPS) we use MINITAB and SPSS to generate the main components (Figure 1).

Eigen analysis of the Correlation Matrix

Eigenvalue	3.4944	1.0871	0.3262	0.0880	0.0044
Proportion	0.699	0.717	0.065	0.018	0.001
Cumulative	0.699	0.916	0.982	0.999	1.000

Variable	PC1	PC2	PC3	PC4	PC5
PPEE	0.411	-0.458	-0.730	0.273	0.112
EEP	0.343	-0.638	0.660	0.194	-0.043
NTP	-0.472	-0.436	-0.170	-0.178	-0.726
EPPE	-0.518	-0.010	-0.037	-0.847	-0.114
PEPS	0.471	-0.439	-0.027	-0.372	0.668

Figure 1: Principal Component Analysis: PPEE, EEP, NTP, EPPE, PEPS. MINITAB17 processing software output.

Tests validating the use of PCA

We can use the size of the eigenvalue to determine the number of principal components. Retain the principal components with the largest eigenvalues., using the Kaiser criterion, you use only the principal components with eigenvalues that are greater than 1. To visually compare the size of the eigenvalues, use the scree plot. The scree plot can help you determine the number of components based on the size of the eigenvalues (Figure 2). In these results, the first two principal components have eigenvalues greater than 1. These two components explain91.6% of the variation in the data. The scree plot shows that the eigenvalues start to form a straight line after the second principal component. If 91.6% is an adequate amount of variation explained in the data, then you should use the first three principal components.

Proportion

a principal component with a proportion of 0.717 explains71.7 % of the variability in the data. Therefore, this component is important to include. Another component has a proportion of 0.001, and thus explains only 0.1 % of the variability in the data. This component may not be important enough to include. In these results, the score for the first principal component can be calculated from the standardized data using the coefficients listed under PC1 (Figure 3).

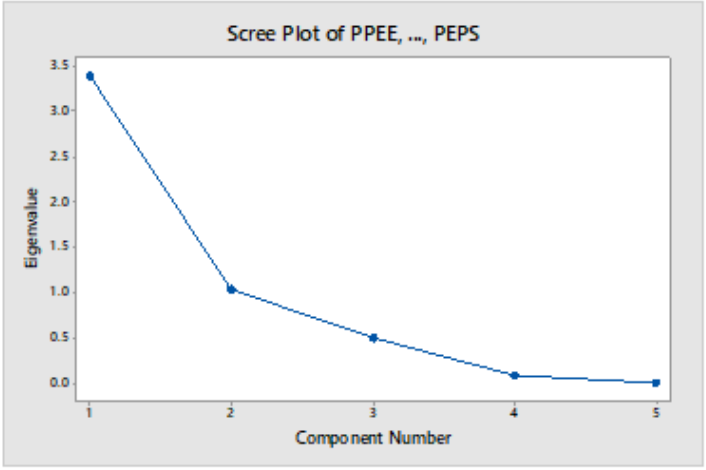

Figure 2:

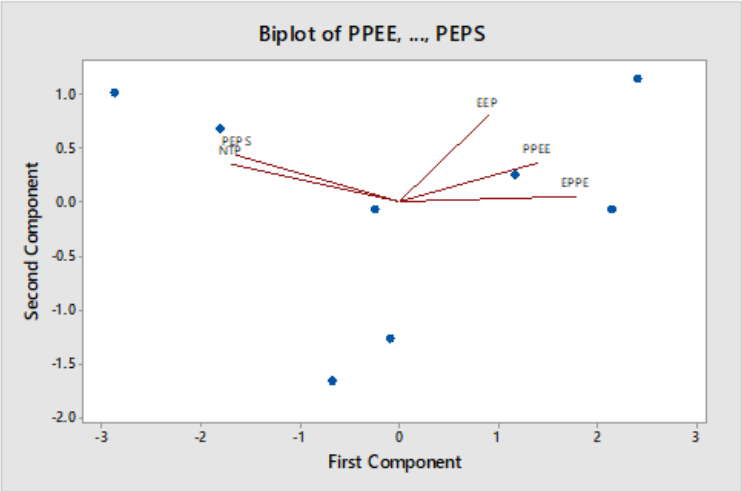

Figure 3:

PC1=0.411PPEE+0.343EEP-0.472NTP+ 0.518EPPE-0.471PEPS

In this loading plot: the pupil- ratio in primary education (PPEE), -expenditure education in% of GDP per capita (EEP), the number of teachers expenditure per pupil in primary education (EPPE) have large positive loadings on component 1, so this component primarily measures applicant'. the number of teachers trained for primary compared to total teachers (NTP) and public expenditure per pupil in secondary (PEPS), have large negative loadings on component 2.

Conclusion

In this study, we applied the Kaiser criterion to determine the number of components to extract. Indeed, according to Kaiser (1960), the extraction of the components must therefore stop as soon as an eigenvalue becomes less than 1. On this basis, we have extracted two main components. In fact, the algorithm used in PCA makes sure to maximize the variance explained by the first component. We therefore succeeded in reducing the data of 5 variables to two permanent components while succeeding in reporting more than70.14% of the initial variance. Consequently, the percentages of inertia are 65.24 % for axis 1 (horizontal axis) and 18.34 % for axis 2 (vertical axis). Thus, the analysis of the component of the eigenvector exposed in the following table clearly indicates that the variables are positively correlated with each of the components. So, she would represent them all pretty much the same way.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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