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# The determinants of health expenditure in Algeria: an application by the autoregressive approach with scaled delays (ARDL)

محددات الإنفاق الصحي في الجزائر: دراسة قياسية باستعمال نموذج الانحدار الذاتي ذو الفجوات المتباطئة ARDL

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**Abstract**

The objective of this paper is to identify the main determinants of health expenditures in Algeria. To this end, we applied the ARDL estimation method to model the long-term and short-term dynamics of the relationship between per capita health expenditures and their determinants during the period 1980-2017. The main empirical results obtained show that the variables: number of doctors per 1000 inhabitants, number of beds per 1000 inhabitants, GDP per capita and public health expenditure in % of total health expenditure have a significant effect on health expenditure in Algeria in the long term. On the other hand, the other variables, i.e. population and population aged over 65 years old, have no significant impact on the evolution of health expenditure either in the long term or in the short term.

**Keywords**: Health expenditure, ARDL approach, determinants, Algeria.

**ملخص**

الهدف من هذه الورقة البحثية هو تحديد المحددات الرئيسية للنفقات الصحية في الجزائر. وذلك باستخدام منهجية الانحدار الذاتي ذو الفجوات المتباطئة ARDL للنمذجة الديناميكية طويلة وقصيرة الأجل للعلاقة بين النفقات الصحية للفرد ومحدداتها خلال الفترة 1980-2017. حيث توصلت النتائج إلى أن المتغيرات: عدد الأطباء لكل 1000 نسمة ، عدد الأسرة لكل 1000 نسمة ، الناتج المحلي الإجمالي للفرد ونفقات الصحة العامة بالنسبة المئوية من إجمالي الإنفاق الصحي ، لها تأثير كبير على الإنفاق الصحي في الجزائر على المدى الطويل. .من ناحية أخرى ، فإن المتغيرات الأخرى ، اي النمو السكاني والسكان الذين تزيد أعمارهم عن 65 عامًا ، ليس لها تأثير كبير على تطور الإنفاق الصحي سواء على المدى الطويل أو على المدى القصير

الكلمات المفتاحية: الإنفاق الصحي ، منهجية ARDL. المحددات ، الجزائر.

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## 1. Introduction

Health care spending has risen sharply over the past 30 years in all developed countries. Everywhere, health expenditures have grown faster than national output, so that their share of gross domestic product (GDP) is now significantly higher than it was thirty years ago.

The growth of health expenditure in most countries of the world has made the study of its determinants one of the most important and well-documented research topics in health economics. Indeed, knowledge of the main drivers of health expenditure growth can contribute to a better control of their future progression.

Numerous research studies have focused on the determinants of health expenditure (Newhouse 1977, Leu 1986, L'Horty et al. (1997), Mahieu 2002, Pereira and Missègue, 2005, etc.) through empirical studies using different investigation methods. Empirical studies on developed countries constitute the bulk of the literature in the field of health expenditure determinants.

In the context of developing countries, we have not identified much work on the determinants of health expenditure. Indeed, empirical studies in developing countries are relatively recent and less abundant than those in developed countries. In particular, we cite research conducted by Gbesmete and Gerdtham (1992), Rahman (2008), and Boachie et al. (2014).

In Algeria, to our knowledge, two empirical studies have been conducted on the determinants of health expenditures. The first study is conducted by Messaili (2018) who focused on the determinants of public health expenditures in Algeria over the period from 1974 to 2010 using an ARDL model approach. He used the ARDL cointegration approach to estimate the relationship between public health expenditures and the variables considered: gross domestic product per capita, infant mortality rate, proportion of the population over 65 years old, number of doctors per 100 thousand inhabitants and number of hospital beds per 100 thousand inhabitants.

The second, meanwhile, is by Ould Abdeslam (2018), who studied the determinants of health expenditures in Algeria over the period 1990-2016 using modeling by the ARDL approach. The author tested the existence of the cointegration relationship between per capita health expenditure, GDP

per capita, total population, the proportion of people aged 60 and over in the total population, medical density, hospital bed density, and public care.

Based on this observation of the insufficiency of work on the main determinants of health expenditure in Algeria, the main objective of this article is to fill this gap, with a view to better control of this expenditure, as highlighted above. Hence the following question: what are the factors that have a significant influence on the growth of health expenditure in Algeria?

In order to achieve our objective, this article is divided into three sections. Section 1 discusses the empirical literature review on the determinants of health expenditures. Section 2 indicates the methodology and presents the data used. It will consist of the implementation of an ARDL model to assess these impacts over an observation period from 1980 to 2017. Section 3 presents the results, their interpretation and discussion.

## 2. Review of the empirical literature on the determinants of health expenditure

Numerous empirical studies have analyzed the determinants of health expenditure. They are generally grouped into three types, depending on the data on which they are based.

### 2.1. First generation: Cross-sectional work (without consideration of the time dimension)

The first econometric studies carried out on cross-sectional data, in the 1970s, sought to study the impact of national income, approximated by GDP per capita, on the volume of health expenditure. The seminal work of (Newhouse, 1977), carried out on a group of 13 OECD countries, concluded that income elasticity was greater than unity (1.35), with GDP alone explaining 92% of variations in health expenditure. Newhouse concludes that health is a higher good.

Later, other studies, notably those of (Leu, 1986) and (Gerdtham et al, 1992), carried out on cross-sectional data, attempted to explain the determinants of health expenditure by investigating the relationship between health expenditure and per capita income. Leu (1986) used the same methodology as Newhouse, but applied it to a larger sample, consisting in this case of 19 OECD countries for the year 1977. He analysed the determinants of health care spending based on the relationship between health care spending and income. He also introduced several variables other

than income. These are mainly variables characterizing the institutional environment, the aim being to avoid any form of approximation that might be generated by the omission of significant variables. His results do not differ greatly from those of Newhouse.

Leu (1986) showed in his study that, all other things being equal, growth in health expenditure was higher in countries with separate financing and delivery of care than in those with integrated national health systems where health insurance and health care delivery are integrated. It also found that supply-side factors can drive health expenditure growth. An increase in the ratio of public sector beds to the total number of beds would lead to increased health spending. When controlling for other factors, other than GDP, the results show that the income elasticity is 1.20 and is lower than that found in the Newhouse studies.

The influence of variables other than income on health expenditure is also highlighted by the early work of Gerdtham et al (1992) on 19 OECD countries with data from 1987. In their study, Gerdtham et al. found that income per capita significantly explained the variance in health expenditure with an elasticity equal to 1.33 that was significantly different from unity. They also found that growth in health care spending would be related to the financing arrangements of health care providers. They conclude that a fee-for-service system increases health expenditure by 11%.

The situation in developing countries is not far from these results. (Gbesmete&Gerdtham, 1992) use a cross-sectional sample of 30 African countries in 1984 and find that GDP per capita is the most significant explanatory factor for health expenditure. However, the elasticity is slightly less than 1. There are other significantly positive factors such as foreign aid received in dollars per capita and the proportion of births by age.

### 2.2. Second Generation: Panel Data Studies

This second generation also built on the Newhouse model, but changed the OLS method to a panel data estimation method, because of the availability of data for several periods.

In their study, Gerdtham and Jonson (1991), using data for 22 OECD countries over the period 1972-1987, introduce several variables other than income: inflation, the share of public financing in health expenditure, and the share of the over-65s in the total population. The estimation results show

that the GDP elasticity is around 0.74. This is lower than what has been obtained on cross-sectional data (Misségue& Pereira, 2005, p. 75).

Hitiris &Posnett, 1992) worked on a sample of 20 OECD countries from 1960 to 1987. They replicated previous studies (using OLS) with panel data. They found, on the one hand, that there was a positive correlation between per capita health expenditure and per capita income and, on the other hand, that the income elasticity was around 1. Consequently, health services are not a luxury good, but rather seem to be closer to the definition of a necessary or normal good. They have demonstrated the importance of other factors such as mortality rate (Misségue& Pereira, 2005).

In 1995, (Gerdtham& al, 1995) extended their first study by using pooled data from 24 OECD countries over the period 1970-1991. The explanatory variables retained concern factors common to all countries, including GDP per capita in volume, but also alcohol consumption, tobacco consumption and the age structure of the population. The authors also introduced variables characterizing the institutional environment specific to each country and more precisely the variable mode of overall organization of the health system (reimbursement, contract or integrated public model). The results obtained from this study indicate that GDP per capita remains the predominant explanatory factor and the income elasticity of health expenditure in volume terms is also estimated at 0.74. The institutional variables, and more particularly the mode of reimbursement of care by the patient and the mode of remuneration of doctors, also appear significant. On the other hand, the results of the estimates reveal that the ageing of the population has no significant effect on the evolution of health expenditure.

Mahieu, 2000) also analyses total health expenditure in volume per capita using data for 20 OECD countries over the period (1970-1993), using as explanatory variables in his model, in addition to GDP per capita in volume, the relative price of health expenditure. In addition, to take account of the impact of technical progress on the evolution of health expenditure, Mahieu used a composite indicator of technical progress based on the rate of renal dialysis, the rate of heart transplants, and the rate of equipment with scanners and magnetic resonance imaging machines. Using these three explanatory variables, while omitting the time parameter, Mahieu arrives at a GDP elasticity of 0.91 and a relative health price elasticity of -0.63. In terms of technical progress, this variable was found to be highly significant.

Institutional factors have also been put forward to explain the growth in health expenditure. In his study, Mathieu (2000) observes a slightly higher trend in expenditure in countries with fee-for-service remuneration than in those with a capitation system. Taking overall institutional specificities into account leads to greater differences, with a higher time trend (1.52%) for the reimbursement system than for the other two systems (0.59% for the integrated system, 0.68% for the contractual system).

Other studies, notably those carried out by Bac and Cornilleau (2002) for the period 1970-1999, and Azizi and Pereira (2005) for the period 1970-2002, have also sought to explain the factors behind health expenditure trends by comparing health expenditure trends in seven OECD countries. The explanatory variables chosen are GDP per capita in volume terms, the relative price of health expenditure, technical progress and the dynamics specific to each country, particularly those linked to the way in which health expenditure is regulated. These studies result in a GDP elasticity of health expenditure per capita of around 0.9 and a relative price elasticity of (-0.9). In addition, they highlight differences in autonomous growth between countries, linked in particular to differences in the way health systems are organized.

Rahman, 2008) analyzed the determinants of public health expenditure using panel data on 14 states in India over the period 1971-1991. The main determinants of health expenditure were found to be: real GDP per capita and literacy rate.

### 2.3. Studies using longitudinal data

In addition to cross-sectional and panel data studies; there are also studies that use only longitudinal data.

In order to understand the overall impact of explanatory factors on the trend in health expenditure, the authors (Murillo et al., 1993, L'Horty et al., 1997, Mahieu, 2000) have used an econometric method that differs from that used in international comparisons. In these studies, the model developed is an error correction model. The authors seek, on the one hand, to test the existence of long-term relationships between health expenditure and the explanatory factors selected and, on the other hand, to measure the role of the factors explaining short-term dynamics.

(Murillo, Piatecki, &Saez, 1993) developed an error correction model separately for each of the ten countries forming the European Community in

1985. They retained two explanatory factors for the evolution of per capita health expenditure in volume: per capita GDP in volume and the relative price of health. The results obtained from this study show income elasticities that are always higher than unity, and schematically lower the richer the country. This reinforces the conjecture that there are important catch-up phenomena during which health expenditure grows significantly faster than national wealth. These results are in line with those obtained in earlier work, in this case by Newhouse.

(L'Horty, Quinet, &Rupprecht F, 1997), on data covering the period 1960-1995, apply a comparable approach for France while broadening the range of explanatory variables. Thus, to the income and price effects considered by Murillo and al. they add institutional parameters (an estimate of the level of public coverage of health care expenditure), demographic parameters (the possible impact of higher medical consumption at extreme ages) and technological parameters. The estimation did not begin until 1970 because of the inadequacy of the data available to them. The results of this study clearly show that, with an income elasticity of 1.25, GDP per capita is very significant and explains most of the evolution of health expenditure. The price elasticity of health expenditure is negative and significant.

L'Horty et al. reach a similar conclusion. According to their work, the share of total health expenditure covered directly by the State via the health insurance funds has a significant positive impact on the volume of expenditure. In this context, they conclude that applying a one point increase in the rate of coverage would lead to a 2% increase in the volume of expenditure. However, this factor could not explain a very large part of the growth in expenditure, as public health insurance has been continuously reducing its level of coverage for the last 15 years (via the increase in the co-payment) to an average rate of 75%. The reference study (Rand experiment) carried out in the United States suggests that the introduction of a co-payment (or co-insurance) of 25% leads the insured to consume 20% less medical care than if they were to receive free care. (Mahieu, 2000, p. 7)

The results of L'Horty et al (1997), concerning the impact of demographic variables (the proportion of the population aged over 65 in the total population, and the dependency ratio, which expresses the ratio of the population aged under 20 and over 65 to the rest of the French population), conclude that the age structure has no role to play in health expenditure.

This finding is corroborated by the results of Gerdtham et al (OECD, 1995), who estimate that the proportion of people over 75 years of age does not significantly influence the amount of health expenditure, and that the proportion of children under 4 years of age has a significant impact only on ambulatory medicine expenditure, not on total expenditure.

The weak impact of aging has also been highlighted by other studies, notably those of Azizi and and Pereira (2005), Dormont et al. (2006) (Dormont, Grignon, & Huber, 2006) and (Barnay&Damette, 2012). Azizi and Pereira (2005) find that between 1970 and 1979, demographics would explain 0.8% of the annual growth in the volume of health expenditures, including 0.6 points for population growth and 0.2 for aging. Dormont et al (2006) find that between 1992 and 2000, demographic changes were responsible for an annual increase in expenditure of 0.9%. Finally, Barnay and Damette (2012), in their study, show that demographic ageing (the share of people aged 65 and over) never appears to be significantly related to health expenditure. For the two authors, the increase in the share of people aged 65 and over has played a moderate role in health care expenditure since 1950, whereas the rise in social security, GDP, medical density and technological progress play a major role.L'Horty et al (1997) also show that the impact of technical progress on the growth of health care expenditure is significant, at around one quarter in France.

To further explain the determinants of health expenditure trends, Mahieu (2000) estimates only supply factors for the period 1970-1993. According to Mahieu, a poor allocation of supply can inevitably lead to an increase in expenditure. Medical density, technical progress and the relative price of health care were the factors that the author looked at. The results of his model were as follows: a price elasticity of health expenditure equal to -0.4, an elasticity of health expenditure to medical density of 1 and an elasticity of health expenditure to technical progress equal to 0.35. It should be noted that this high value of elasticity to medical density is probably due to the fact that supply factors alone are taken into account to explain the evolution of health expenditure.

Boachie & al, 2014) studied the determinants of public health expenditure in Ghana over the period 1970 to 2008 by applying the Engel-Granger cointegration test. The results of this study showed that the variables: real GDP, life expectancy at birth, crude birth rate, literacy rate, and inflation rate positively impact public health spending.

(Messaïli, 2018) studied the determinants of public health expenditure in Algeria over the period 1974 to 2010, adopting a supply and demand approach, using the ARDL cointegration approach over the period from 1974 to 2010. The explanatory variables chosen are: the gross domestic product per capita, the infant mortality rate, the proportion of the population over 65 years of age, the number of doctors per 100 thousand inhabitants and the number of hospital beds per 100 thousand inhabitants. The results of the long- and short-run estimates show that the main determinants of public spending in Algeria are GDP per capita, the number of doctors and the number of hospital beds per 100 thousand inhabitants. On the other hand, the other selected variables, namely the infant mortality rate and the proportion of the population over 65 years old, are significant neither in the long nor in the short term.

(OuldAbdeslam, 2018) also studied the determinants of health expenditures in Algeria, over the period 1980-2017, using an ARDL modeling approach. The author took as explanatory variables: GDP per capita, total population, the proportion of 60 years and older in the total population, medical density, hospital bed density, and public care. The results of this study show that the variables: public coverage, total population, medical density and hospital bed density have a significant effect on the dynamics of health expenditure. On the other hand, the variables GDP per capita and the population aged 60 and over do not have a significant impact on the evolution of health care expenditure.

## 3. Econometric methodology and choice of variables

In order to take better account of the factors likely to influence health expenditure in Algeria, we propose to apply the ARDL estimation method.

### 3.1. Econometric methodology

To analyze the main determinants of health expenditure in Algeria, we have opted for the ARDL (Auto Regressive Distributive Lags) model. The use of this model is justified by the fact that it takes into account both the short and long term relationships of the variables tested. It also allows the estimation of variables with different levels of integration I (I) and I (0). Indeed, the ARDL test does not require that the variables of the model are purely I (I) or I (0). Moreover, the method is relatively more efficient for

small samples, as is the case for most empirical studies of developing countries.

The data used come from four sources: the National Statistics Office (ONS), the Ministry of Health, Population and Hospital Reform (MSPRH), the World Health Organization (WHO) and the World Bank. We will conduct a longitudinal study on annual data covering the period from 1980 to 2017. All these variables were logarithmically transformed.

### 3.2. Choice of variables

In order to determine the different variables used in this study, we drew heavily on the review of the empirical literature on the determinants of health expenditure developed in the first section of this article.

#### 3.2.1. The dependent variable

In order to identify the main determinants of health expenditure in Algeria, we consider per capita health expenditure (PCE/HAB) as the dependent variable.

#### 3.2.2. Explanatory variables

In order to analyze the main determinants of health expenditure in Algeria, we refer to the literature review developed in the first section of this article. We will use two categories of health factors: supply factors and demand factors.

#### 3.2.2.1. Care supply factors

Among the factors of health care supply, we distinguish the number of doctors per 1000 inhabitants and the number of beds per 1000 inhabitants.

#### 3.2.2.2. Demand for care factors

Among the factors of demand for care, we retain the GDP per capita, the population, and the population over 65 years of age and the public provision of care measured by the share of public health expenditure in total health expenditure.

**Table 1.** The variables used in the study and the expected signs

| Variables | Description |
|---|---|
| **Gross domestic product per capita (GDP)** | + |
| **The number of doctors per 1000 Inhabitants (DOC)** | + |
| **The portion of the population over 65 years old ( POP> 65)** | + |
| **Public health expenditure as % of total health expenditure (PH )** | + |
| **Total population (POP)** | + |
| **Number of the beds per 1000 inhabitants (BED)** | + |

**Source:** Prepared by the researcher

## 4. Results and discussion

This section presents the results of the econometric analysis used to identify the type of relationship that exists between per capita health expenditure and its determinants in Algeria. To do this, we first check the stationarity of the series.

### 4.1. Unit root test for the variables

Before testing the cointegration between the variables, it is important to conduct the unit root test to ensure that no variable is integrated at order 2 I(2). This is essential because the ARDL procedure assumes that all variables are integrated of order I(0) or I(1). To identify the order of integration of our variables, we use the Augmented Dickey-Fuller (ADF) test (Bourbonnais, 2015, p. 249). The results of the ADF unit root test for the variables are shown in the table number 2.

**Table 2:** Table of the stationarity

| | **In level** | | **First diffrence** | | **Integration order** |
|---|---|---|---|---|---|
| | **T Statistics** | **Probability** | **T Statistics** | **Probability** | |
| **Log PCE/HAB** | -2.644514 | 0.2643 | -5.502412 | 0.0004* | I(1) |
| **Log GDP** | -1.791702 | 0.6879 | -3.571587 | 0.0467** | I(1) |
| **Log POP** | -1.121512 | 0.3025 | -4.589565 | 0.0352** | I(1) |
| **Log PH** | -2.181876 | 0.4852 | -7.232914 | 0.0000* | I(1) |
| **Log DOC** | -1.524959 | 0.8026 | -5.805846 | 0.0002* | I(1) |
| **Log POP>65** | -1.252625 | 0.9025 | -3.252363 | 0.0001* | I(1) |
| **Log BED** | -3.367096 | 0.0715 | -5.953475 | 0.0001* | I(1) |

***Significant at 1%, ** Significant at 1%, *** significant at 10%.**

**Source:** Compiled by the researchers from Eviews 10.

The application of the ADF unit root test on the series studied leads to the rejection of the stationarity hypothesis for all the series. The results also show that all the series are integrated of order one I(1), so no series is integrated of order two I(2) or more. This is crucial for the application of the ARDL approach.

### 4.2. The ARDL cointegration test and model estimation

We will use the Akaike Information Criterion (AIC) to select the optimal model, the one that provides statistically significant results with

fewer parameters. The estimation results of the selected optimal ARDL model are presented in Table 3.

**Table 3.** Estimation of the ARDL (2, 1, 0, 1, 1, 2, 0)

| Variables | Coefficient | Std.Error | t-statistic | Prob |
|---|---|---|---|---|
| **Log PCE/ HAB(-1)** | 0.160036 | 0.207158 | 0.772531 | 0.4480 |
| **Log PCE/ HAB(-2)** | -0.368528 | 0.191320 | -1.926238 | 0.0671 |
| **Log PH** | 1.369431 | 0.883237 | 1.550468 | 0.1353 |
| **Log PH (-1)** | 1.127475 | 0.901831 | 1.250207 | 0.2244 |
| **Log POP** | 0.142054 | 0.208366 | 0.681750 | 0.5025 |
| **Log DOC** | 2.834460 | 1.101929 | 2.572272 | 0.0174 |
| **Log DOC (-1)** | -1.794278 | 0.990615 | -1.811278 | 0.0838 |
| **Log GDP** | -3.613618 | 2.788382 | -1.295955 | 0.2084 |
| **Log GDP (-1)** | 5.247740 | 2.607630 | 2.012456 | 0.0566 |
| **Log BED** | 1.038895 | 1.055673 | 0.984107 | 0.3358 |
| **Log BED (-1)** | 1.805101 | 1.060258 | 1.702512 | 0.1027 |
| **Log BED (-2)** | 3.219820 | 1.684618 | 1.911306 | 0.0691 |
| **Log POP> 65** | -0.227909 | 0.869965 | -0.261975 | 0.7958 |
| **C** | -39.39219 | 10.07374 | -3.910384 | 0.0008 |
| **R2= 0.95=):(Statistic= 35.53692 ;Prob=0.0000:DW=2.17** | | | | |

**Source:** Compiled by the researchers from Eviews 10

### 4.2.1. Optimal shift and estimation of the ARDL mode

An important step in the framework of dynamic models is the determination of the optimal number of lags to consider (Farjallah&Abdelhamid, 2017). To achieve this, different criteria are often used, the most common of which are: the Akaike Information Criterion (AIC) and the Schwartz Information Criterion (SIC) (KibalaKuma, 2018, p. 7). The top twenty models, according to the information criterion (AIC), are the ARDL model ((2, 1, 0, 1, 1, 2, 0) considered the optimal model, which corresponds to the smallest value of AIC. The results are shown in Figure 1.

### 4.2.2. Bounds test for cointegration

In order to test the cointegration between per capita health expenditure and the variables under consideration, we will use the ARDL Bounds Test. The main purpose of the Bounds Test is to inform us about the existence of a cointegrating or long-run relationship between the variables (Farjallah &Abdelhamid, 2017). The F-statistics calculated for the cointegration test are presented in Table No. 4.

**Table 4.** ARDL Bound test

| Meaning | I0 Bound | I1 Bound |
|---|---|---|
| **10%** | 1.99 | 2.94 |

| | | |
|---|---|---|
| **5%** | 2.27 | 3.28 |
| **2.5%** | 2.55 | 3.61 |
| **1%** | 2.88 | 3.99 |
| **F-Statistics** | 4.1404896 | |

**Source:** Compiled by the researchers from Eviews**10**

Bounds test results show that the Fisher statistic (F=4.1404896) is outside the lower and upper bounds for the different significance levels. We conclude that there is a long-term relationship between per capita health expenditure and the determinants considered in this study.

### 4.3. Study of the short and long term relationship

Having verified the existence of a long-run relationship between per capita health expenditure and the determinants considered in this study, we turn to the study of the long-run and short-run relationship by examining their significance levels.

#### 4.3.1. Estimation of the long-term relationship

After confirming the existence of a long-term relationship between the variables, we will proceed to estimate it. Table 5 presents the results of the long-term equilibrium.

**Table 5.** Long term relationship

| Variables | Coefficients | Std.Error | T-Statistic | Prob |
|---|---|---|---|---|
| **Log PH** | 2.066133 | 0.802703 | 2.573968 | 0.0173 |
| **Log POP** | 0.117546 | 0.162768 | 0.722172 | 0.4778 |
| **Log DOC** | 1.860727 | 0.369971 | 2.326471 | 0.0096 |
| **Log GDP** | 0.852199 | 0.800899 | 1.688352 | 0.0030 |
| **Log BED** | 5.017673 | 0.863030 | 5.814019 | 0.0000 |
| **Log POP> 65** | -0.188590 | 0.723469 | -0.260674 | 0.7968 |
| **C** | -32.59616 | 5.841949 | -5.579672 | 0.0000 |

**Source:** Compiled by the researchers from Eviews 10.

**LogPCE/HAB =** -32.59616+ 2.066133 *Log PH + 0.117546* Log POP+1. 860727*Log DOC + 0.852199* Log GDP +5.017673* Log BED- 0.188590*Log POP> 65.

The results of the long term relationship of the ARDL model show the positive impact of the public health expenditure variable on the dynamics of health expenditure in Algeria. A 1% increase in public spending leads, all other things being equal, to a 2.06% increase in per capita health spending. This result is consistent with the results of L'Horty et al, who conclude that public coverage has a positive impact on the volume of expenditure: a one-point increase in the rate of coverage would lead to a 2% increase in the volume of expenditure.

Similarly, the results of the long-term estimates show that the variable number of doctors per 1000 inhabitants is highly significant and positively correlated with the level of health expenditure. When the number of doctors per 1000 inhabitants increases by 1%, health expenditures would increase by 1.860%. In addition, the long-term results show that the number of beds per 1000 inhabitants appears to be one of the main determinants of health expenditure in Algeria; a 1% increase in the number of beds leads, all other things being equal, to a 5.17% increase in health expenditure. This result corroborates the results of empirical studies by Messaïli (2018) and OuldAbdeslam (2018) which concluded that, medical density and hospital bed density have a significant effect on the dynamics of health expenditures. It is also consistent with the hypothesis of (Rochaix, 1997) that supply creates its own demand (induced demand). The more supply increases, in terms of the number of doctors or hospitals, the more the population's demand for health care increases. This influence of supply on demand is called the phenomenon of induced demand.

Another factor that we believe to be equally important in explaining the evolution of health care spending is GDP per capita. Our results show that GDP per capita has a statistically significant positive elasticity at the 1% threshold and less than unity (1). This means that the health good is not a superior good, contrary to previous empirical studies by de Newhouse (1977), carried out in cross-section on thirteen countries, which conclude that income elasticity is significantly greater than unity (1.35). Similarly, the work of the OECD (2008) shows that in all its member countries, the elasticity of per capita health expenditure (in PPP USD) with respect to per capita gross domestic income (GDI) (in PPP USD) is 1.4.)

This result is consistent with the results of the empirical study by Messaili (2018), which concludes that GDP per capita positively impacts public health spending with an income elasticity of less than unity (0.891). This means that the health good is not a superior good, but rather a necessary good. In contrast, the study by OuldAbdeslam (2018) found that GDP per capita does not have a significant impact on the evolution of health expenditures.

In contrast to previous empirical studies, the results of our study show that the population variable does not appear to have a positive impact on health spending in either the long or short run. This result is surprising and in disagreement with the study by Dormont et alii, conducted on French data

from 1992-2000, which concluded that demographics can contribute up to 3% to the increase in health care spending. This result also disagrees with the result of the empirical study conducted by Ould Abdeslam (2018), which concluded that an increase of 1%, would lead to a growth in health expenditures, in the long term, of 3.48%.

Furthermore, the results of our study clearly show that the variable population over 65 years of age is not significant in either the short or long term. This result is consistent with the results of many studies on aging such as Gerdtham et al. (1995), l'Horty et al. (1997) and (Dormant, 2009) who explain that aging plays only a minor role in explaining the growth of health care expenditures. Although there is no consensus in the economic literature on the impact of population ageing on health expenditure growth, several studies nevertheless seem to indicate a positive correlation between population ageing and health expenditure, such as the work of Bac and Comilleau (2002). This result is also consistent with the results of empirical studies by Messaili (2018) and OuldAbdeslam (2018), focusing on the case of Algeria, which conclude that the variable population aged over 65 years does not have a significant impact on the evolution of health expenditure.

### 4.3.2. Estimation of the short-term relationship

After estimating the long-term relationship, we will proceed to estimate the short-term relationship. Table 6 presents the estimates of the short-term dynamics between per capita health expenditure and its determinants.

**Table 6.** Estimation of the short- term relationship

| Variables | Coefficients | Std.Error | T-Statistic | Prob |
|---|---|---|---|---|
| **D (Log PCE/HAB(-1))** | 0.368528 | 0.141916 | 2.596806 | 0.0165 |
| **D (Log HP)** | 1.369431 | 0.625067 | 2.190854 | 0.0393 |
| **D (Log DOC)** | 2.834460 | 0.715344 | 3.962373 | 0.0007 |
| **D (Log GDP)** | -3.613618 | 1.776944 | -2.033614 | 0.0542 |
| **D (Log POP)** | 1.038895 | 0.635993 | 1.633502 | 0.1166 |
| **D (Log POP (-1))** | -3.219820 | 1.245983 | -2.584161 | 0.0169 |
| **CointEq (-1)** | -0.984092 | 0.209997 | -5.754814 | 0.0000 |

**Source:** Compiled by the researchers from Eviews 10.

The short-term results show that the error correction coefficient CointEq (-1) is negative and largely significant for our model, confirming the existence of an error correction mechanism. This coefficient, which

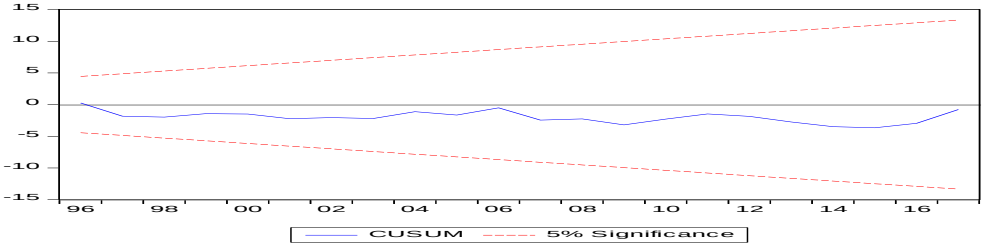
expresses the degree to which the per capita health expenditure variable will be recalled towards the long-run target, is estimated at 98% for our model, reflecting a rapid adjustment to the long-run target for our model. The results of the short-run estimates do not show differences in the impact of the population variables and the population over 65 years of age. These variables remain insignificant in both the long and short term.

The public expenditure variable remains a determinant of health expenditure in Algeria even in the short term. It has an elasticity of 1.37 lower than that found in the long-run estimates. Concerning the variable number of doctors per 1000 inhabitants, the results of our estimations confirm that this variable has a positive influence on the growth of health expenditure in both the short and long term. As for the variable number of beds per 1000 inhabitants, this also remains significant at the 5% threshold and with an impact that remains positive, with an elasticity of 1.03, which is less important than in the long term.

### 4.4. Study of the stability of the model

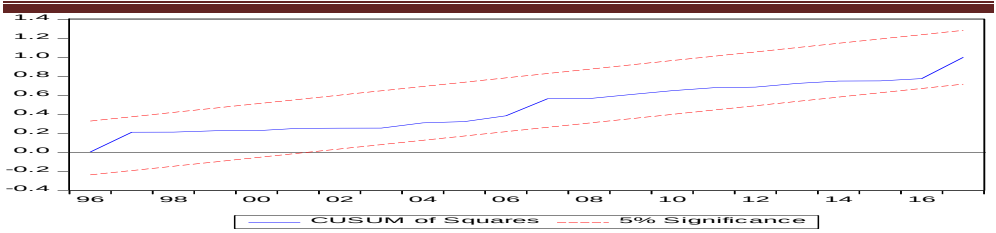
In order to examine the level of constancy of the model's parameters, we will use the CUSUM (Cumulative Sum) and CUSUMSQ stability test. The CUSUM and CUSUMSQ tests clearly show the stability of the long-term relationship over the estimation period between per capita health expenditure and its determinants (see Figures 1 and 2).

**Fig. 1.** Cumulative sum of residual curve




**Source:** Compiled by the researchers from Eviews 10.

**Fig.2.** Cumulative sum of squares curve of the residual




**Source:** Compiled by the researchers from Eviews 10.

### 4.5. Robustness test

To check the validity of our model and the relevance of the variables used, we will conduct robustness tests, namely serial autocorrelation, normality of Jarque-Bera residuals and heteroscedasticity (Bourbonnais, 2015, p. 244). Table 7 presents the results of the different validity tests used: It shows that the model is valid. Indeed, its residuals are free of autocorrelation (prob= 0.27), heteroscedasticity (prob= 0.48) and are normally distributed (Prob= 0.).

**Table7.** Validity test

| **Breusch-Godfrey error autocorrelation test** | |
|---|---|
| F-statistic :0.782773 | Prob. F(2,20) :0.4706 |
| Obs*R-squared :2.613413 | Prob. Chi-Square(2) :0.2707 |
| **Breusch-Pagan-Godfrey hetroscedasticity test** | |
| F-statistic :0.681816 | Prob. F(2,31) : 0.5131 |
| Obs*R-squared :1.432579 | Prob. Chi-Square(2) : 0.4886 |
| **Normality Test (Jaque Bera)** | |
| Jaque Bera : 0.45 | Prob :0.79 |

**Source:** Compiled by the researchers from Eviews 10.

### 5. Conclusion

The objective of this article was to analyze the determinants of health expenditure in Algeria. To do so, we applied the ARDL cointegration approach to evaluate the long and short term dynamics of health expenditure. Six explanatory factors were selected: the share of public expenditure in total health expenditure used as a proxy for public provision, GDP per capita, the number of beds and doctors per 1000 inhabitants, population and the population aged over 65 years, as the main factors that led to the growth of health expenditure in the Algerian context.

The results of our study show that public spending has a positive impact on the evolution of health expenditures in Algeria in both the long and short term. Moreover, the econometric results show that GDP per capita does not seem to be one of the main determinants of health expenditure.

Our results show a positive elasticity, but less than unity. A 1% increase in GDP leads, all other things being equal, to a 0.85% increase in health expenditure. Thus, the econometric results confirm that health is a necessary good.

The long- and short-term estimates reveal that the variables: number of beds and number of doctors per 1000 inhabitants have positive and statistically significant elasticities at the 1% threshold. The number of beds per 1000 inhabitants has the highest elasticity of all the determinants of health expenditure; a 1% increase in the number of beds leads, all other things being equal, to a 5.17% increase in health expenditure. Similarly, a 1% increase in the number of physicians leads to an increase in health expenditure of about 1.86%. The results show that the supply of health care exerts its pressure on health care expenditure through the number of beds per 1000 inhabitants and the number of doctors per 1000 inhabitants. Thus, this result suggests that the regulation of health care expenditure must be fundamentally a regulation of the supply of health care and must be among the priorities of the public authorities.

## 6. Bibliography List

Azizi, K., & Pereira, C. (2005). Comparaison internationale des dépenses de santé: une analyse des évolutions dans sept pays (1970- 2002) . *Dossiers solidarité et santé* (1), pp. 43-60.

Bac, C., & Cornilleau, G. (2002). Comparaison internationale des dépenses de santé : une analyse des évolutions dans sept pays depuis 1970 . (DREES, Éd.) *Etude et Résultats* (175).

Barnay, T., & Damette, O. (2012). *What drives Health Care Expenditure in France since 1950? A time-series study with structural breaks and non-linearity approaches* .

Boachie, M., & al. (2014). Determinants of Public Health Expenditure in Ghana: A Cointegration Analysis. *Journal of Behavioural Economics, Finance, Entrepreneurship, Accounting and Transport, 2* (2), pp. 35-40.

Bourbonnais, R. (2015). *Économétrie: Cours et exercices corrigés* (éd. 9ème). Paris: Dunod.

Dormant, B. (2009). *Les dépenses de santé. Une augmentation salutaire?* Paris: Editions Rue d'Ulm.

Dormont, B., Grignon, M., & Huber, H. (2006). Health expenditures growth: reassessing the threat of aging . *Health Economics* (15), pp. 947-963.

Farjallah, N., & Abdelhamid, M. (2017). Effet de l'instabilité des institutions politiques sur la croissance économique en Tunisie : une approche par le modèle ARDL. *International Journal of Economics&Strategic Management of Business Process (ESMB), 8* (2), pp. 148-157.

Gbesmete, K., & Gerdtham, U. (1992). Determinants of Health Care Expenditure in Africa: A cross-Sectional Study . *World Developement, 20*, pp. 303-308.

Gerdtham, U., & al. (1992). An Econometric Analysis Of Health Care Expenditure: a cross-section study of the OECD Countries . *Journal of Health Economics* , pp. 63-84.

Gerdtham, U., & al. (1995). *Factors affecting Health spending : a cross-country econometric analysis New Direction in Health Care Policies : Improving Cost Control and Effectiveness, OCDE, 1995.* New Direction in Health Care Policies : Improving Cost Control and Effectiveness, OCDE, .

Gerdtham, U., & al. (1995). Factors affecting Health spending : a cross-country econometric analysis. Dans OCDE (Éd.), *New Direction in Health Care Policies : Improving Cost Control and Effectiveness.*

Hitiris, T., & Posnett, J. (1992). The determinants and effects of health expenditure in developed countries . *Journal of Health Economics, 11*, pp. 173-183.

Kibala Kuma, J. (2018). *Modélisation ARDL, Test de cointégration aux bornes et Approche de Toda-Yamamoto : éléments de théorie et pratiques sur logiciels.* Congo-Kinshasa.

L'Horty, Y., Quinet, A., & Rupprecht F, F. (1997). Expliquer la croissance des dépenses de santé : le rôle du niveau de vie et du progrès technique . *Économie et Prévision* (129), pp. 257-268.

Leu, R. (1986). The public-private mix and international health care costs. Dans C. A. (eds), *Public and Private Health Services, Basil Blackwell, Oxford.*Basil Blackwell, Oxford.

Mahieu, R. (2000). *Les déterminants des dépenses de santé : une approche macroéconomique , Séries des documents de travail de la Direction des Études et Synthèses Économiques, Insee.* Séries des documents de travail de la Direction des Études et Synthèses Économiques, Insee.

Messaïli, M. (2018). Dépenses publiques de santé, santé de la population et croissance économique en Algérie . *Thèse de Doctorat en Économie et Gestion* . Université de Bejaia.

Misségue, N., & Pereira, C. (2005). Les déterminants de l'évolution des dépenses de santé . *Dossiers solidarité et santé* (1), pp. 61-83.

Murillo, C., Piatecki, C., & Saez, M. (1993). Health care expenditure and income in Europe. *Journal of health economics, 2*, pp. 127-128.

Newhouse, J. (1977). Medical-Care expenditure: A cross national survey . *Journal of Human Resources* (12), pp. 115-125.

Ould Abdeslam, S. (2018). Analyse des déterminants des dépenses de santé en Algérie . *Thèse de Doctorat en Sciences Économiques* . Université de Bejaia.

Rahman, T. (2008). Determinants of public health expenditures: Some Evidence from Indian States. *Applied Econometrics Letters* (15), pp. 853-857.