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The dynamic relationship between health care expenditure and national income in Benin context

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Summary: This paper provides empirical evidence on the relationship between per capita health care expenditure and national income in Benin, over the period from 1990 to 2020, using AutoRegressive Distributed Lag (ARDL) approach. After controlling for domestic government health expenditure as share of total health expenditure, foreign health expenditure as share of total health expenditure, proportion of population aged less than 15 years old and proportion of population aged over 65 years, we found that the long-run elasticity of health care with respect to gross domestic product is ranged from 0.529 to 0.676 suggesting that health care is income inelastic for Benin's citizens. Our results remain stable when re-estimating the same health expenditure equation by Fully Modified Ordinary Least Squares and Dynamic Ordinary Least Squares methods. Since income elasticity of demand for health care expenditure is less than one, higher income may not automatically imply higher health expenditure by Benin population.

Keywords: Health care expenditure – Bound testing – Heath financing – Benin.

La relation dynamique entre les dépenses de santé et le revenu national dans le contexte du Bénin

Résumé *: Cet article fournit des preuves empiriques sur le lien entre les dépenses de santé par habitant et le revenu national à l'aide des données béninoises couvrant la période 1990-2020, et d'un modèle autorégressif à retards échelonnés (ARDL). Après avoir évalué la part des dépenses de santé du gouvernement dans les dépenses totales de santé, la part des aides extérieures en santé dans les dépenses totales de santé, la proportion de la population âgée de moins de 15 ans ainsi que celle âgée de plus de 65 ans, nos résultats montrent que les élasticités revenu à long terme des dépenses de santé varient de 0,529 à 0,676, ce qui suggère que les soins de santé sont inélastiques par rapport au revenu. Les résultats restent stables lorsque nous réestimons l'équation de dépenses de santé par les méthodes des moindres carrés ordinaires modifiés et des moindres carrés ordinaires dynamiques. L'élasticité-revenu de la demande de dépenses de santé étant inférieure à un, l'augmentation du revenu national ne se traduit pas automatiquement à travers une augmentation des dépenses de santé de la population béninoise.*

Mots-clés *: Dépenses de santé – Bound testing – Financement de la santé – Bénin.*
JEL Classification*: H51 – I10 – I15 – O55.*

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1. Introduction

Health care is viewed by the economists as well as input in health production function and core component of human capital investment (Grossman, 1972). Thus, a well-targeted rise in health care spending leads to human capital development with macroeconomic multiplier impacts through positive externalities. For instance, the increase in national health expenditure (public spending) brings social changes in terms of poverty reduction and inequalities in access to basic social services and the fight against priority diseases (Byaro et *al.*, 2018). Moreover, increasing in national health care expenditure would tend to increase labour productivity, productivity of investments in other form of human capital, quality of life, life expectancy, and general welfare (Knowles and Owen, 1995; Byaro et *al.*, 2018). The benefits of a well-targeted rise in health care expenditure could especially be more important for the developing countries like Benin. Health outcomes such as life expectancy at birth, maternal mortality and infant mortality remain low (Ministry of Health, 2018). Besides, over the period 2000-2020, the per capita Gross Domestic Product (GDP) growth rate averaged 4.6% while the total health expenditure as a percentage of GDP averaged around 4.286 %. The trends of the share of health expenditure in GDP and the growth of GDP seem to move in the same direction. The domestic government health expenditure as a percentage of total health care expenditure, donor health expenditure as a percentage of total health care expenditure and out-of-pocket health expenditure as a share of total health care expenditure are respectively 31.09%, 24.33% and 44.03% (World Bank, 2022). Health care services are provided by a network of public and private sectors, and the geographical distribution of services including health facilities and health workers are biased against rural areas. 74% of the health facilities are in urban areas against 26% in rural areas (Ministry of Health, 2018). Furthermore, 48% of the private health facilities are concentrated in the south region (Ministry of Health, 2018). People's access to health services appears to be determined by the degree of urbanization of the community in which the household lives, the availability of health services in the community and the household's socioeconomic status (Ministry of Health, 2018). Socioeconomics context also shows that the incidence of poverty has increased over passing from 28.9% in 1995 to 40.3% in 2017 and urbanization rate of 48.4%. Thus, understanding the determinants of health expenditure is important for Benin to formulate more effective health policies (Braendle and Colombier, 2016).

There are several reasons for examining the determinants of health care. First, a review of the literature on the topic shows substantial work on the macroeconomic determinants of health expenditure in developed countries (Gerdtham et al., 1992; Kiymaz et *al.*, 2006; Baltagi and Moscone, 2010; Farag et *al.*, 2012). A few studies in developing countries, particularly those in Africa, have been conducted (Kouassi et *al.*, 2018; Barkat et *al.*, 2018). These empirical studies focused on what explains variation of health care expenditure across countries. They also vary in terms of periods and panel of countries covered, variables used, and econometric specifications adopted (Kiymaz et *al.*, 2006; Barkat et *al.*, 2016; Barkat et *al.*, 2018).

Second, the findings of these works suggest that difference in health care expenditure across countries have been attributed to income level. But there is no consensus on whether health care is income elastic or not. In addition, their results cannot be generalized because the empirical analysis conducted at the aggregate level do not capture the complexity of the economic and historical environment of each country. Consequently, any inference drawn from previous studies provides only a general understanding of how the variables are broadly related. Moreover, they do not provide relevant guidance for policy formulation for a given country. Therefore, a country-specific case study seems more relevant to find in deep and detailed answers to the question regarding the optimal amount of health expenditure that Benin allocates to the health of the population.

Knowing income elasticity of health care would help to plan health care reforms by giving policy makers some appropriate guidance on efficient allocation of the resources. For instance, if health care is a necessity (income elasticity less than unity) then health care service should not be left to the dictates of markets forces. So, if we know what determines the quantity of resources Benin devotes to medical care, then, innovative methods of financing the system can be found. To the best of our knowledge, analysis of health expenditure dynamic focusing exclusively on Benin does not currently exist. Therefore, the main contribution of the article to literature is that it is one of the few attempts that analyses the dynamic relationship between health expenditure and national income in Benin context.

The objective of this paper is to investigate the existence of a long-run relationship between health care expenditure and national income, controlling for some of its major determinants using standard demand theory and AutoRegressive Distributed Lag (ARDL) modelling approach. Unlike traditional approaches for cointegration (Engle and Granger, 1987; Johansen and Juselius, 1990) that require all series are integrated of order one, the ARDL bound testing approach allows testing for cointegration when it is not known with certainty whether the regressors are purely I(0), purely I(1) or mutually integrated (Pesaran et *al.*, 2001). Endogeneity problems (for example, reverse causality between health spending and income) and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle and Granger (1987) method are avoided when using ARDL. In addition, the long and short-run parameters of the model are estimated simultaneously (Ghosh, 2009). We cross-check the robustness of the long-run estimates derived from ARDL modelling approach by using Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) as alternatives specifications. The reasons for doing this are twofold: first, apart from correcting for endogeneity bias-and serial correlation effects, these estimators are also suitable to produce reliable estimates in small sample size.

The rest of the paper proceeds as follows. Section 2 discusses literature review. Section 3 highlights the empirical methodology issues, while section 4 presents data and descriptive statistics. The results are discussed in section 5. The study concludes in section 6 with some concluding remarks.

2. Literature review

Since the pioneer work of Newhouse (1977), several studies identify factors influencing the quantity of resources a country devotes to health care (Hitiris and Posnett, 1992; Hansen and King, 1996; Kiymaz et *al.*, 2006; Rodriguez Llorian and Mann, 2022). Most of these analyses use a demand function approach to specify a model in which real per capita health expenditure is expressed as a function of real gross domestic product and other control variables. Many studies find that there is a strong and positive correlation between health care expenditure and gross domestic product. However, there is no consensus on the magnitude of income elasticity of health care expenditure.

2.1. Health care as a luxury good

Initial studies use cross sectional data from developed countries in general and the Organisation for Economic Co-operation and Development (OECD) countries in particular, and reveal that per capita income is an important factor determining health care expenditure. Moreover, some of these earlier studies find that income elasticity of health care expenditure is greater than one, implying that health care is deemed to be a luxury good (Newhouse 1977; Parkin et al., 1987; Milne and Molana, 1991; Gerdtham et al., 1992). Newhouse (1977), for example, uses data from 13 OECD countries in year 1970 to estimate income elasticity that is greater than one. In the same vein, Gerdtham et al. (1992) estimate the income elasticity of health expenditure as 1.33 which is significantly greater than one based on data from 19 OECD countries in year 1987. Parkin et al. (1987) use a methodology of cross-sectional data and they also classify health care as a luxury good. These findings generate a vital debate on whether health care is a luxury or a necessity (Pattnayak and Chadha, 2016). If income elasticity for health care is higher than one, its production and consumption is best left to the market forces, just like any good or service (Di Matteo, 2003; Pattnayak and Chadha, 2016). In contrary, if health care is income inelastic, the growth in health care expenditure falls below the growth in income and requires government intervention for its efficient production and distribution (Di Matteo, 2003; Kouassi et al., 2018). Results from cross-sectional data are fragile and criticized owing to the smallness of many of the data sets used and the assumption of homogeneity of health care across countries. With respect to this, Hitiris and Posnett (1992), for example, use pooled cross-country observations from 20 countries of the OECD countries over the period 1960-1987 to estimate individual country pooled cross-section. The authors reach to similar conclusion with previous cross-sectional studies. Controlling for cross-section dependence and unobserved heterogeneity, Zhou et al. (2020) also find an income elasticity of health care expenditure greater than one for a sample of 22 emerging countries. Using data from Australia and error correction model, Ang (2010) argues that the income elasticity for health care is greater than one.

2.2. Health care as a necessity good

In contrast to developed countries, cross-section regressions on developing countries including African show an income elasticity of health care expenditure less than unity implying that health care seems to be a necessity good. For instance, using cross-sectional data on 30 African countries for year 1984 and weighted least squares corrected for heteroskedasticity, Gbesemete and Gerdtham (1992) found an income elasticity of health care expenditure is ranged between 0.88 and 1.07. In the same vein, from a flexible Box-Cox model regression method and cross-sectional data of 26 African countries for year 1995, Okunade (2005) concludes that income elasticity of health expenditure is 0.65. Murthy and Okunade (2009) reach similar results using large cross-sectional data from 44 African countries for year 2001, and Ordinary Least Squares (OLS) and robust least absolute error estimators. In addition, many countries, however, show an elasticity of health care expenditure with respect to income greater than one except for Mauritania, Kenya, Malawi, and South Africa.

Sahn (1992) used a panel data of 23 Saharan African countries covering 1974-1987 and country fixed effects estimator. His results suggest that gross domestic product elasticity of health care spending was slightly elastic (1.17 for 1974-79, 1.06 for 1980-84, and 1.17 for 1985-89). However, the aggregate expenditure elasticity of health spending was slightly below one (respectively 0.67 for 1974-1979 and 1980-1984, and 0.96 for 1985-1989). Using a panel of 15 OECD countries over 1990 to 1998 and two-way fixed effect models, Sen (2005) concludes that several estimators yield similar result with respect to income elasticities of per capita health expenditures (between 0.21 and 0.51). In the same vein, Farag et *al.* (2012) used a panel data set for 173 developed and developing countries for the period 1995-2006 and found that health care has income elasticity less than one. However, the authors show that health care spending is least responsive to changes in low-income countries and most responsive in middle-income countries with high-income countries falling in the middle.

Some researchers point out the presence of trending the variables and suggest that the time series properties of the data vary between countries with the consequence that the panel data estimates of health care expenditure and gross domestic product may be spurious. For instance, Hansen and King (1996) use data for 20 OECD countries for the period from 1960 to 1987, and report that health care expenditure and gross domestic product show a long-run relationship. Using data on 21 OECD countries over the period 1960-1997, Gerdtham and Lothgren (2000) find that there is a co-integrating relationship between Health Care Expenditure (HCE) and GDP. More recently, Baltagi and Moscone (2010) have used a panel of 20 OECD countries within cross-section dependence and unobserved heterogeneity context. Their findings suggest that health care is a necessity rather than a luxury, with elasticity much smaller than that estimated in previous studies. Kouassi et *al.* (2018) also find an income elasticity less than one for a panel of 14 southern African development community.

Other researchers use a country-specific case study and time series analysis. For instance, Kiymaz et *al.* (2006) find a long-run relationship between the per capita private, public, and total HCE and per capita GDP and population growth for Turkey during the period of 1984-1998. In addition, a statistically significant bivariate co-integrating

relationship between the private health expenditure and gross national product were found and that there exists one-way causality running from income to various definitions of health care expenses. In the same vein, Shiu and Chiu (2008) report that the Taiwan health care expenditure, income, population ageing, life expectancy and the number of practicing physicians have statistically significant long-run economic relationships for the period 1960-2006. In Malaysia, Khan et al (2016) use the auto-regressive distributed lag model bound approach and suggest that an income elasticity less than one.

Other researchers have used non-parametric and panel threshold regression approaches. For instance, using United States level data for the period 1980-1997, Canadian province level data for the period 1965-2000, and national level data for 16 OECD countries for the period 1960-1997**,** Di Matteo (2003) finds out that the relationship between health spending and income is not a simple linear relationship. In addition, he suggests that for the United States, Canada, and the OECD countries, health spending is relatively income elastic at lower levels of income and more inelastic at higher levels of income. Moreover, income elasticity does vary by level of analysis with international income elasticities (OECD) being generally larger than national or regional studies (United States and Canada). From a panel threshold regression for 17 OECD countries over the period 1975-2003**,** Chakroun (2010) concludes that income elasticity of health care expenditure is less than one. Also, the relationship between health expenditure and income seems rather nonlinear and changes over time and across countries. Considering a semi-parametric panel data analysis for 42 African countries over the period 1995-2009, Zhike and Zhu (2014) conclude that income elasticity of health spending varies with income level, and health care is a necessity for African countries.

2.3. Other health care expenditure drivers

It is important to note that in estimating the income-elasticity of health care, several control variables, like demographic structure, health conditions etc. were incorporated in health care demand analysis. For example, the foreign aid is found to be positively and significantly correlated with health expenditure (Gbesemete and Gerdtham, 1992; Okunade, 2005). Shiu and Chiu (2008) find positive and significant impact of dependency ratio on HCE while the ratio of dependency is found to be negatively and significantly related to health care spending (Okunade, 2005). In addition, most research shows that age structure or population ageing has a small or non-significant impact on HCE (Murthy and Okunade, 2009; Zhike and Zhu, 2014; Zhou et *al.*, 2020). Similar conflicting results are found for urbanization rate and health status (Sen, 2005; Zhike and Zhu, 2014).

3. Methodological approach and data

3.1 Economic model

Economic theory of the macroeconomic of analysis of health care spending provides a weak guidance with respect to possible determinants of aggregate health expenditure, and causal mechanisms involved (Gerdtham and Jonsson, 2000; Okunade, 2005). Exception is the public choice framework of Leu (1986) who provides a highly selective explanation. Thus, following economic theory and previous empirical studies (for example Ang, 2010; Baltagi and Moscone, 2010; Kouassi et *al.*, 2018), we model real per capita health expenditure (hce) in Benin as function of real per capita gross domestic product (gdp), domestic government health care spending as a share of total health expenditure (ghc), foreign health care spending as a share of total health expenditure (ehc), proportion of population under 15 years old ($p15$) and proportion of population with age equal or above 65 years old ($p65$). $hce = f(gdp, ghc, ehc, pop15, pop65)$. The following health care demand function was specified to investigate the relationship between health expenditure and income controlling for its other drivers:

$$hce_t = \beta_0 + \beta_1 gdp_t + \beta_2 ghc_t + \beta_3 ehc_t + \beta_4 p15_t + \beta_5 p65_t + \varepsilon_t \quad (1)$$

Where, t and ε denote time and white noise error term respectively. In equation (1) only hce and gdp are in logarithm. We expect all parameters to be found positive.

Indeed, the standard demand theory suggests that increasing income leads to an increase demand for good quality health services due to an increase in the marginal utility of health services (Hall and Jones, 2007). According to Leu (1986), the expansion of public provision of health care leads to a reduction in the price of health care services with a consequent increased consumption of health services. Population age structure may have an impact on the health care expenditure because advancing age tends to create a substantial demand for health care (Lichtenberg, 2014). There is a likelihood of chronic illnesses at the old age developing into functional disabilities among the elderly. So, both increases in population size and changes to the age structure of the population may create a pressure on health care expenditure.

3.2 Estimation procedures

Since our data are annual time series variables, we start by performing some pre-estimation test using the augmented Dickey and Fuller (ADF) (Dickey and Fuller, 1979) and Phillips and Perron (PP) (Phillips and Perron, 1988) unit root tests procedure to obtain the order of integration of the variables. The null hypothesis of ADF and PP tests for the existence of unit root is that the series are non-stationary. These tests because assuming stationarity while the variables are non-stationary leads to spurious regression (Engle and Granger, 1987). The variables in our model were a set of integrated of order one, I(1), and integrated of order zero, I(0) (Table 2). So we applied the Autoregressive Distributed Lag (ARDL) modelling approach of Pesaran et *al.* (2001) to estimate equation 1, and to capture the long-run impact of changes in income health care expenditure variation. Based on Pesaran et *al.* (2001), the following ARDL model is specified to investigate the short run dynamic of health expenditure:

$$\Delta hce_t = \alpha_0 + \sum_{i=1}^{n-1} a_{1i}\Delta hce_{t-1} + \sum_{i=1}^{n-1} a_{2i}\Delta gdp_{t-1} + \sum_{i=1}^{n-1} a_{3i}\Delta ghc_{t-1} + \sum_{i=1}^{n-1} a_{4i}\Delta ehc_{t-1} + \sum_{i=1}^{n-1} a_{5i}\Delta p15_{t-1} + \sum_{i=1}^{n-1} a_{6i}\Delta p65_{t-1} + \beta_1 hce_{t-1} + \beta_2 hce_{t-1} + \beta_3 ghc_{t-1} + \beta_4 ehc_{t-1} + \beta_5 p15_{t-1} + \beta_6 p65_{t-1} + \varepsilon_t \quad (2)$$

In equation (2), Δ represents the first difference operator of the respective variable, n the lag length and α_0 is the deterministic drift parameter. The optimal lag lengths of the variables are automatically selected using Akaike's Information Criteria (AIC). The existence of the cointegrating relationships between the model variables in the long-run can be tested by imposing restrictions on the estimated long-run coefficients of one period lagged level of the variables equal to zero. The test is stated below as: $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ (no cointegration between the variables) versus $H_a: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$ (Existence of cointegration between the variables).

The bounds test approach is performed using a non-standard F-test developed by Pesaran et *al.* (2001) and further modified by Narayan (2005) for small samples. We compare the calculated F-statistics to their critical values. Cointegration may be found if the calculated F-statistic exceeds the upper critical bound. In addition, the long run relation is inconclusive if the calculated F-statistic lies between the lower and the upper critical values. If we reject the null hypothesis of no cointegration in equation (3), following the procedure in Pesaran et *al.* (2001), we estimate the following unrestricted error-correction model:

$$\Delta hce_t = \alpha_0 + \sum_{i=1}^{n-1} a_{1i}\Delta hce_{t-1} + \sum_{i=1}^{n-1} a_{2i}\Delta gdp_{t-1} + \sum_{i=1}^{n-1} a_{3i}\Delta ghc_{t-1} + \sum_{i=1}^{n-1} a_{4i}\Delta ehc_{t-1} + \sum_{i=1}^{n-1} a_{5i}\Delta p15_{t-1} + \sum_{i=1}^{n-1} a_{6i}\Delta p65_{t-1} + \lambda ECT_{t-1} + \mu_t \quad (3)$$

where λ is the speed of adjustment parameter, and Error Correction Term (ECT) is the residuals from the estimated Equation (3). The ECT captures the health care expenditure evolution process by which agents adjust for prediction errors made in the last period. The stationarity of the ECT provides evidence that the long-run relationship exists.

We also apply the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squared (DOLS) to cross-check the robustness of the long-run estimates derived from ARDL. All estimations are subject to various diagnostic tests.

3.3 Data

We used annual data from Benin over the period from 1990 to 2020. The data series were collected from the World Development Indicators (2022) and Benin's National Institute of Statistics and Demography (INStaD). The dependent variable is per capita real health expenditure. The independent variables included in our analysis are the gross domestic product per capita expressed in constant prices, the share of domestic government health expenditure to total health expenditure, the share of external health expenditure to total health expenditure, the percentage of the population aged less or equal to 15 years and the percentage of the population aged over than 65 years. These variables were selected based on the empirical literature on health care expenditure determinants.

3.3.1 Preliminary Analysis

The descriptive statistics of the variables used in the regression analysis are presented in table 1. Over the study period, the average total health expenditure per capita is $US 25.583 against $US 80.763 for Africa. The mean of the gross domestic product per capita is $US 729.706 with a standard error of $US 372.744. Average share of domestic government health care expenditure in total health care expenditure is 32.076 % against 20.637% for the share of foreign health care spending in the total health care expenditure. Compared to Africa, these percentages are lower (35.208 % and 24.027 % respectively). The average value of the percentage of people aged over 65 years is 3.403% which is greater than the average value of 2.045 for Africa. According to United Nations (2015) projection, aging population is expected to increase in Africa in the coming years.

Table 1: Summary statistics: 1990-2020

Variables	Obs	Mean	Std. Dev.	Min	Max
hce	36	25.583	5.731	15.907	39.101
gdp	36	729.706	372.744	244.411	1291.41
ghc	36	32.076	9.997	19.603	45.999
ehc	36	20.637	6.565	11.651	36.238
$p15$	36	44.511	1.168	41.945	45.794
$p65$	36	3.403	0.266	3.156	4.04

The results reported in Table 2 indicate that health care expenditure per capita, GDP per capita, domestic government health care spending as share of total health care expenditure, foreign health care expenditure as share of total health care spending and the proportion of the population aged less than 15 years old are integrated of order one, I(1), while the proportion of the population aged equal or above 65 years is integrated of order zero, I(0). This result means that ordinary least squared estimation of equation 1 leads to spurious conclusion (Engle and Granger, 1987). Therefore, we apply ARDL bound testing approach to cointegration which is appropriated whether the variables are purely I(0), purely I(1) or a set of I(1) and I(0) (Pesaran et *al.*, 2001).

Table 2: Unit root testing using the ADF and the PP tests

Variables	Model	Augmented Dickey Fuller Test (ADF)		Phillips Perron Test (PP)		Decision
		Levels	First Difference	Levels	First Difference	
hce	Trend	-2.153	-3.809***	-2.108	-5.455***	I(1)
	none	0.477	-3.854***	0.474	-5.546***	I(1)
gdp	Trend	-1.681	-5.935***	-2.454	-8.56***8	I(1)
	none	2.346**	-6.042***	2.307	-7.635***	I(1)
ghe	Trend	-1.527	-5.084***	-2.109	-7.670***	I(1)
	none	-0.917	-5.168***	-2.109	-7.814***	I(1)
ehc	Trend	-3.085	-6.985***	-2.109***	-10.786***	I(1)
	none	0.642	-6.823***	0.504	-10.778***	I(1)
$pop15$	Trend	-1.021	-3.897**	-2.736	-3.968**	I(1)
	none	-2.738*	-0.359**	-4.173	-0.659	I(0)
$pop65$	Trend	-2.682**		-2.174**		I(0)
	none	0.627		-3.601**		I(0)

Notes: (***), (**), (*) indicate 1 %, 5 % and 10 % level of significance, respectively.

4. Results and discussions

The ARDL bounds testing approach to cointegration reported in table 3 indicates that the computed F-Statistics, that is, 9.547 is greater than the upper bound critical value at the 1, 5 and 10 % level of significance. This result suggests that a cointegrating relationship is found between per capita health expenditure and its determinants in the case of Benin over the period from 1990 to 2020.

Table 3: The results of the cointegration test

Pesaran et *al.* (2001) ARDL Bounds test to cointegration		
Estimated Equation	$hce = f(gdp, ghc, ehc, pop15, pop65)$	
Optimal lag structure	lag(1 0 2 0 1 0)	
F-statistics	9.547***	
T-statistics	-5.814	
Significance level Critical	**Critical values**	
	Lower bounds (I0)	Upper bounds, (I1)
1 percent	3.410	4.683
5 percent	2.625	3.796
10 percent	2.261	3.352
Diagnostic tests		Statistics
R^2		0.958
Adjusted R^2		0.942
F-statistic		61.190
Prob > F		0.000

The optimal lag lengths of the variables are automatically selected using Akaike's Information Criteria (AIC). (***), (**), (*) indicate 1%, 5% and 10% level of significance, respectively.

Having established that cointegration relationship exists between per capita health care expenditure and its determinants, we now turn to the estimation of the long and short run coefficients of the demand of health care expenditure. The results of the long-run model estimates using unrestricted error-correction model procedures are presented in Table 4. In Table 4, the long-run ARDL cointegration model (1 0 2 0 1 0) are selected automatically by applying the Akaike Information Criterion (AIC).

The diagnostic tests for both the short and the long run models show that the error terms are normally distributed, and they are serially uncorrelated. There is also no evidence of autoregressive heteroscedasticity and misspecification in the models. Thus, the diagnostics tests support the validity of a long-run equilibrium relationship among per capita health expenditure, gross domestic product, domestic government health expenditure in total health expenditure, foreign health expenditure in total health expenditure, proportion of population aged less than 15 years old, and the proportion of population aged over 65 years old. We further check for the stability of the health expenditure equation for an effective health policy. The cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) plots show that the movements of both CUSUM and CUSUMSQ lie within the 5% critical lines indicating that the model coefficients did not shift over the sample period (see graph 1 and 2 in appendix). Besides, as expected, the sign of the estimate of the lagged error term, i.e., ECT_{t-1}, which measures the speed of adjustment back to the long-run equilibrium value, is negative and statistically significant at 1 percent level of significance. This provides further evidence against no cointegration, and therefore confirms the long run relationship between the variables established earlier. The coefficient of ECT_{t-1} is -0.567 implying that 56.7 percent of the change in Benin's health expenditure demand per capita is attributed to disequilibrium (Narayan and Narayan, 2004).

Table 4: The long-run results of the health care expenditure equation, 1990-2020

	Coefficients	**Std. error**	***T-stat***	**P-values**
Panel A: The long-run equilibrium level relationship ($Dep = hce$)				
Intercept	-3.185*	-1.711	-1.86	0.075
gdp	0.529***	0.137	3.84	0.001
ghc	0.009*	0.005	1.85	0.077
ehc	0.027***	0.005	4.91	0.000
$p15$	0.102**	0.049	2.08	0.049
$p65$	0.016	0.165	0.10	0.921
Diagnostic checks	Test-statistics			
J-B normality test	0.847			0.655
DW	1.822			
LM test	0.037			0.215
ARCH test	34.001			0.894
CUSUM	Stable**			
CUSUMsq	Stable**			

Notes: J-B refers to the Jarque–Bera statistic of the test for normal residuals, DW is Durbin Watson test for serial autocorrelation of order one, (***), (**), (*) indicate 1%, 5% and 10% level of significance, respectively.

Table 4 shows that the coefficients of income per capita have positive sign as expected and are statistically significant at one percent level. The long-run elasticities of health care expenditure with respect to income per capita is 0.529. The results imply that health care is a necessity or normal good at the aggregate level in Benin because when income per capita increases by 1%, health care expenditure increases less than one percent. These findings are consistent with most of previous studies on African countries (i.e. Okunade, 2005; Zhike and Zhu, 2014; Murthy and Okunade, 2009; Kouassi et al, 2018), but are contrary with studies on developed countries which found some income elasticities of health care expenditure greater than one. Health care is income inelastic in relation to national income meaning that health care expenditure grows proportionally less than income growth. The fact that the long-run income elasticities of health care expenditure is less than one may be explained by the fact that in poverty context people prioritize making food available than health care. Another explanation is that health insurance is lacking so that people access to health care depends on their personal income. The findings from income elasticity are important because it offers guidance regarding health care financing policy. According to Costa-i-Font et *al.* (2009), the value of income elasticity provides insight into the optimal level of health expenditures in the economy.

Gross domestic government health care expenditure as share of total health care expenditure enters in the long-run health care expenditure equation significantly at 10% level with the expected positive sign. The coefficient is 0.009. The positive long-run relationship between the share of government health expenditure in total health care expenditure is in line with Leu (1986) and Ang (2010) which have found a positive impact of public finance on health care expenditure. The effects of foreign health expenditure in total health care expenditure are found to be like those of domestic government health expenditure, but the magnitude and the level of statistical significance of the coefficients on foreign health care expenditure are slightly higher than that of domestic government health expenditure. These results make sense because public sector finance is important source of health care financing in Benin. These findings are consistent with our prior expectation because foreign aid expands resources frontier to finance health care. The positive impact of aid reinforces the tendency for health care to behave like a necessity.

With respect to the population variables, they enter positively and significantly as expected in the health expenditure equation. In most regression, the coefficients on proportion of population aged over 65 years are found to be higher than those on the proportion of population with age less than 15 years old. While the long-run effect of the proportion of the population aged over 65 years is 0.016 while that of the proportion of the population aged less than 15 years old is 0.102. These findings support the viewpoint that demographic factors are important in explaining the variation in health care expenditure. Another possible explanation is that as population increases, public expenditure crowds out private health expenditure because low-income people are less able to cope with health issues that are involuntary. Consequently, they rely more on public provision. The long-run impact of an increase of 10% in point in population growth rate on total health spending is comprised between 1.77% and 2.19% against

2.29% to 6.08% for public health expenditure. The positive long-run impact of population growth rate on total and public expenditure could be also justified. In Benin, population growth rate is driven by higher birth rate due to high fertility rate. A higher fertility implies a higher share of children in the population and higher health care costs for pregnant women and children. These are in line with Hall and Jones (2007) and Kiymaz et *al.* (2006) who argued that an increase in share of health expenditure may be the result of population growth.

Results of the long-run model estimated by using FMOLS and DOLS are presented in Table 5. The three methods provide similar results, confirming the robustness of the long-run results. The long-run coefficients on all variables in the health expenditure equation are positive as expected, and statistically significant at the conventional 5 percent level except population aged over 65 years variable for unrestricted error-correction model estimator. We noticed that for both FMOLS and DOLS results all variables enter positively in the health expenditure equation with a level of statistically significance of 1 percent. The magnitudes of the coefficients appear reasonable across estimator.

Table 5: The long-run results of the health care expenditure equation: Robustness checks

	FMOLS				DOLS			
	Coefficients	Std. error	*t-stat*	p-values	Coefficients	Std. error	*t-stat*	p-values
Int.	-24.079***	7.024	-3.43	0.001	-5.439***	0.744	7.31	0.000
gdp	0.676***	0.095	7.10	0.000	0.626***	0.039	15.91	0.00
ghc	0.014***	0.002	4.94	0.000	0.019***	0.001	20.69	0.000
ehc	0.020***	0.004	4.96	0.000	0.028***	0.001	15.33	0.000
p15	0.416***	0.132	3.16	0.002	0.062**	0.010	5.87	0.000
p65	0.780**	0.305	2.55	0.011	0.172***	0.041	4.19	0.000
Dia.	Test-statistics							
Nor.	1.219			0.417	1.759			0.306
DW	1.530				1.530			
LM	1.530			0.215	1.532			0.215
AR.	1.222			0.2694	0.018			0.894

Int.= intercept; Dia.=Diagnostic checks; Nor.=Normality test; LM.=LM test; AR.=ARCH test; (***), (**), (*) indicate 1%, 5% and 10% level of significance, respectively.

5. Conclusion and policy implication

The paper examines the existence of long-run relationship between health care expenditure, gross domestic product, population growth rate and foreign aid in Benin. Using annual time series data from 1990 to 2020, the results show that per capita health expenditure tends to rise with per capita national income, but the increase for health care is less than proportional to the rise in income. Public health care expenditure as a share of total health care spending tends to increase with per capita health care spending.

Finally, age structure of the population explains the growth of per capita health expenditure.

The fact that health care is a necessity for Benin's citizen has two economic implications for health care financing reforms. First, the public health sector has not been accorded a high priority in the Benin's agenda of social and economic development. Health authorities should more increase health spending in relation to the rise in income per capita because the optimal amount of health spending for Benin is not yet reached. Second, it also implies that public participation in the provision of the basic health care is highly justified because the demand for health care seems to be more related to physiological health and has to do with health status such as mortality, morbidity, etc. Furthermore, the increasing of public provisions for health care can increase the scope of redistribution of health care resources since such provision is financed by pooled fund, mostly taxes, where people from different income groups contribute. This viewpoint is in line with the lower development of health insurance in Benin. People may face higher cost of health care. As shown in United Nation agenda 2030, like other African countries, the proportion of people aged over 65 years is increasing in Benin, so more public expenditure is expected to deal with the health conditions of this category of population.

6. References

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7. Appendix

Table 1: The short-run dynamic model (Δhce)

	Coefficients	Std. error	*t-stat*	p-values
Intercept	-3.185*	1.711	-1.86	0.075
Δgdp	0.0531***	0.008	6.62	0.000
$\Delta\ ghc$	0.009**	0.002	3.31	0.003
$\Delta\ ghc$ (-1)	0.005*	0.002	2.00	0.057
Δehc	0.021	0.023	0,91	0.437
$\Delta p15$	0.364	0.225	1.61	0.120
$\Delta p65$	0.032	0.035	0,91	0.451
$ECT\ (-1)$	-0.567***	0.097	-5.81	0.000

Notes: () indicates the t-stats, and (***), (**), (*) indicate 1%, 5% and 10% level of significance, respectively.

Figure 1: Plots of cumulative sum of recursive (CUSUM)

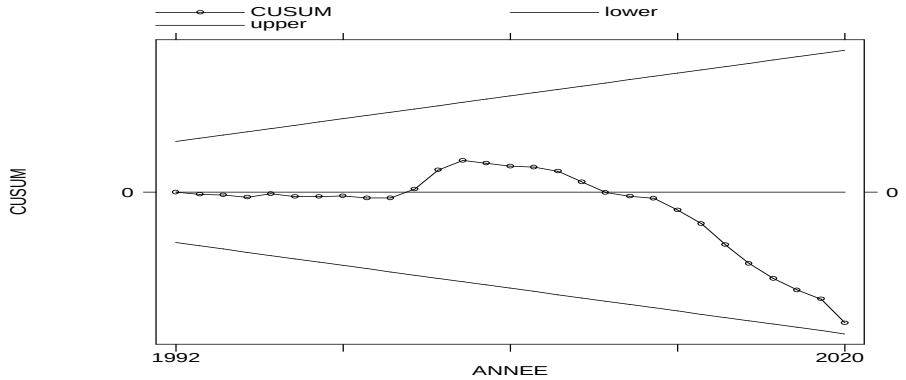

Figure 2: Cumulative sum of squares of recursive residual (CUSUMsq)