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# Evaluation of Development Gap on the Effects of Wealth on Healthcare Expenditure in Oil Exporting Countries

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***Abstract:*** *The world income inequality has caused inequality in the world health dimensions. Healthcare expenditures are part of the development strategies in most countries. Understanding how international differences in population health are affected by economic conditions and Income inequality is important. This study investigates the sources of existing differences in the levels of health-care expenditure in these countries and finds the related convergence/divergence evidences in different income groups. The study focuses on the balanced panel data from 71 countries for the period between 2006 and 2018.This study is used two methods of analysis: Bayesian quantile regression and Bayesian Markov chain Monte Carlo methods. The sampling method is based on the Human Development Index (HDI).Results have revealed that the coefficients are different in these three groups; their GDP share of the health expenditure is different In addition, standard software modeling has shown the acceptable performance of the Bayes inference, the problem divergence has been confirmed and its convergence has been demonstrated. The findings of the effect of Wealth on healthcare financing are in line with theoretical literature; their GDP share of the health expenditure is different. Since healthcare is a necessity, such results require noticeable policy implications, especially for the low-income group, and governments need to track the trend of the economic variations and help health investments. Designing financial incentives by improving insurance plans, providing benefit packages, applying better expense control strategies, and so on are what policy-makers should focus on.*

***Keywords:*** *Health expenditure, Wealth, Oil exporting countries, Bayesian dynamic panel models, Development Gap*

**JEL Classifications: H51, O 47, O10.**

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## 1. Introduction and Background

Health problems, due mainly to democracy issues, economic conditions, government potentials, trade relationships with foreign countries, and the provided health services, are increasingly studied in different societies especially where the elderly population has an increasing trend. As countries get richer and richer, the total expenditure on health increases globally. Policymakers need not only to know why health expenditures increase, but they should also find out if these increased expenses on health facilitates will result in universal coverage and will finally improve people's health (Stepovic 2019).

Although the amount both the government and households can spend on health is important as regards the income of a country, it is not the only factor because health expenses vary greatly in countries with similar income levels. In group three countries (low-income) where such expenditures are less than the least amount needed for basic service provisions, more health-related resources should be provided from people and the private sector, but group two countries (high-income) where expenses on health are high should try to enhance the value they earn for their money through different ways (Ke *et al*. 2011).

In a new report on global health expenditures, the World Health Organization (WHO) has shown that they have a rising trend and the health sector continues to grow faster than the economy; in the period 2000-2017, the latter grew 3.0% a year while that of the former was 3.9% globally. In middle-income countries, convergence toward higher spending levels is fast; health expenses, in the same period, have risen by 6.3% while economy has had an increase rate of 5.9%. In group three countries, the increase in health expenses has been 7.8%. About 80% of the global spending has been by high-income countries, but the increase in middle-income countries has been 6% (from13 to 19%) in the same period. (Fig 1) shows that the real growth in health spending averaged around 2% in 2017 and 2018.

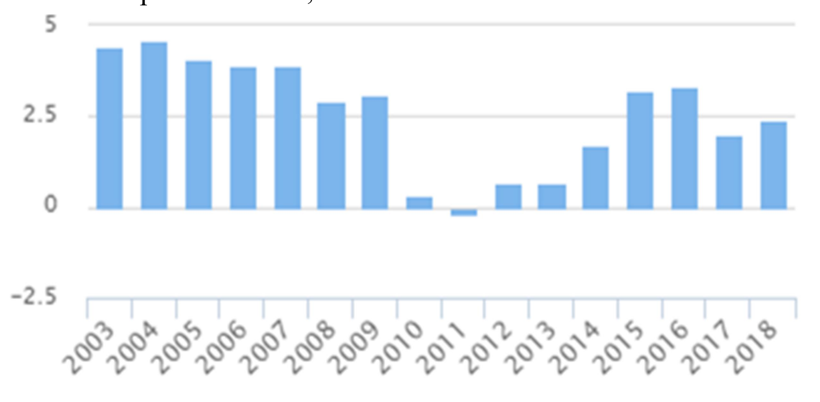


Fig 1. Average real health spending growth (OECD Health Statistics 2019)

(Fig 2) shows, based on evidences, that the improved health and welfare over the last few decades has improved the at-birth life expectancy in many countries.

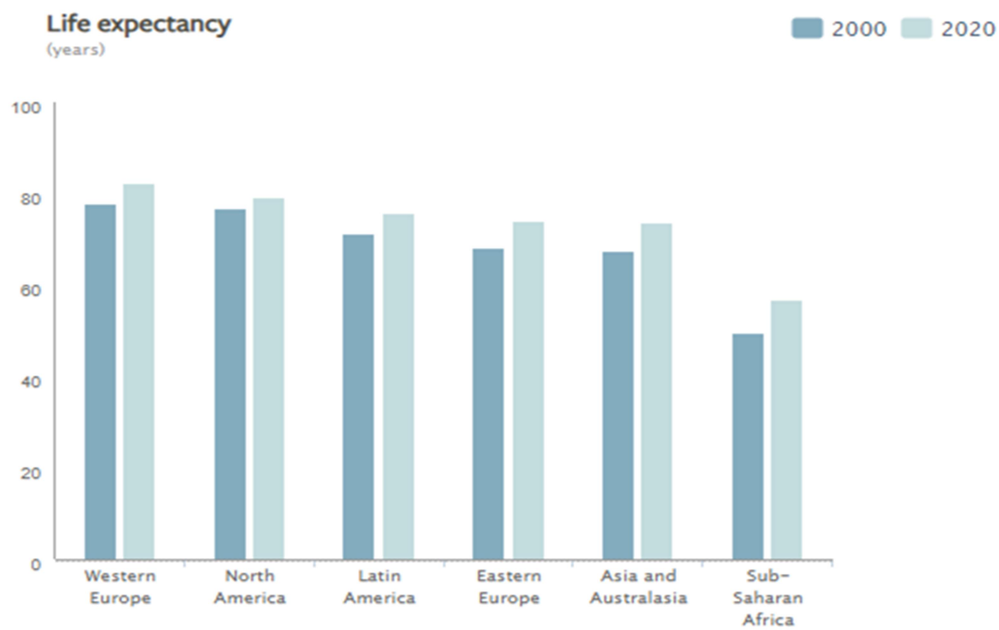


Fig 2. life expectancy comparison 2000-2020 (Economist Intelligence Unit)

The wealth countries spend on health varies greatly across the globe compared to that spent for the economic development, and since data from developing countries is almost none, effort has been made in this paper to fill this gap by collecting data, including the GDP per capita, life expectancy at birth, death ratio, and population status, from 71 developed/developing countries and using them in the study as the major variables in health expenditure estimations. Oil-exporting countries were grouped, based on the HDI (human development index) into very high-income, high-income, and middle-to-low-income countries which is quantified according to a country's human development indices such as education, health, and life expectancy and is set on a 0 to1 scale (0.8 for most developed countries) (Human Development Data 2018).

Since very few studies have focused on the healthcare convergence issue for a set of specific countries, the cross-country disparity analysis has not received much attention in this context despite its potential importance and usefulness.Effort has been made in this study to reveal the issue among oil-exporting countries considering the basic health-expenditure determinants, and investigate, despite the limited choice of variables as regards the data availability, the sources of the existing differences in the levels of the healthcare expenses among oil exporting nations and find evidences why the healthcare expenses converge/diverge in different income groups.However, an appropriate health policy needs a proper understanding of the countries' economic behavior which, in turn, requires knowing the factors involved in the related strategy choices besides those determining the related expenditures.

Next, the literature is reviewed in Section 2, the econometric model and the related data are explained in Section 3, empirical results are provided in Section 4, the discussion in Section 5, and the conclusions plus some policy implications are presented in Section 6.

## 2. Literature review

Determining and understanding what factors affect the healthcare expenditures and how international differences in population health are affected by socioeconomic conditions is a serious task challenged by policymakers/researchers.

The global health coverage can be achieved by a political process driven by a wide range of social forces, or a simultaneous income and health costs increase, which leads to more health services, or increasing the share of the health expenses most of which are paid directly by individuals and families; exceedance of the accumulated costs is a necessary condition but not a sufficient one (Savedoff *et al*. 2012).

The total health expenditure is the sum of the public and private spending that covers both the preventive and curative services along with emergency and rehabilitative health services for the entire population. The budget allocated in a fiscal year by the Ministry of Finance of a country for health expenditures has been reported by different studies to be different for the developed and developing countries (Sisko *et al*. 2014).

Some authors (Kleiman 1974; Newhouse 1977; Leu 1986; Getzen 2000) believe that the GDP is quite a vital health expense determining factor that explains how the overall healthcare expenses differ in different countries.

It is well-documented that the income inequality at the international level is associated with various mental and physical health problems. Contrarily, the health inequality is primarily a within-country phenomenon (Pradhan *et al*. 2003), the more egalitarian countries have better health (Lynch *et al*. 2000).

The literature has reported that besides income, there are other variables the effects of which on the health spending are different; while some studies (Okunade *et al*. 2004) see the effects positively, some other ( Leu 1986; Hitiris and Posnett 1992; Gerdtham and Jönsson 2000; Jönsson and Eckerlund 2003) believe that the effects are statistically unimportant.

Barkat *et al* (2018) used the panel cointegration method to empirically examine the healthcare spending determinants for 18 Arabian countries during 1995–2015 and showed, through the results, that income was not the only long-run health expenditure driver; other variables (medical advances, aging, etc.) too played an important role in increasing the healthcare expenses. The increased healthcare expenditure could not only result in higher labor efficiency and economic growth, but also in a better life quality.

By enlarging the spatial-temporal ranges of the earlier samples and considering infants' deaths, life expectancy and calorie consumption, Cole WM (2019) used the 1970-2015 data of 134 developing countries to check how the economic growth affected the health and used 2-phase models and instrumental variables to separate the causal growth effects. He showed that the 5-year growth rate of the economy improved all three health results even after controlling other effective factors and considering the probability of reverse causation and highly affected the infants' deaths rates; the health growth benefits reduce as countries become more affluent.

In their studying 19 OECD countries between 1972-2006, Panopoulou and Pantelidis (2012) provided evidence of GDP convergence for 17 of them. Through a simple GDP decomposition, the United States and Norway showed that the US divergence was due to that of the 'healthcare expenses to the GDP ratio' and that of Norway was due to the 'labor productivity'.

Using the ACL data, HRS surveys and large Afro-American and white-race subsamples, Ostrove *et al*.(1999) examined what some SES indicators meant and how they were related to health, and concluded that wealth contributed highly and uniquely to explain the mental/physical health, and that various indicators appeared to have similar effects on the health of the mentioned races.

Using the GMM, FE-IV and the 1995-2012 yearly data of 45 countries in the Sahara region, Barkat *et al*. (2016) observed that the health expenses in the countries of groups two and three increased averagely by about 0.2 and 0.51%, respectively for a 1% real GDP increase.

Newhouse (1977) believed that the income variations affected those in the healthcare expenses, but authors of Hitiris and Posnett (1992); Hansen and King (1996) rejected this issue; they added the death rate, the proportion of the population above 65, and share of public finance in health expenditures. Variations in per capita GDP explain the changes in per capita health expenditure among countries. Researchers believe that the health expenditure income elasticity needs to be compared with 1; Hitiris (Hitiris 1997; Clements *et al*. 2003), some believe it is about 1 (Gbesemete and Gerdtham 1992; Santiago *et al.* 2013), and some argue that it is below 1 (Jaunky and Khadaroo 2008; Baltagi and Moscone 2010). Yet, Devin and Hansen (2001) found no causality between the health expenditure and the economic growth. However, Amiri and Ventelou (2012); Balaji (2011); Elmi and Sadeghi (2012); Hartwing (2010); Tang (2011) found mixed results. Others paid attention to this research thread; some micro studies (Grossman 1972; Muurinen 1982; Wagstaff 1986) showed a correlation between the healthcare use and income explaining that most individuals are subsidized or do not have to pay the full price of using healthcare resources. Bloom *et al*. (2001); Rivera and Currais (2003); Mizushima (2008); Akram *et al*. (2011) found a positive relationship between the health and economic growth.

Recently, the external funds-national health expenditure relationship has found popularity in developing countries; Van der Gaag and Stimac (2008) found that although the health-specific official development aid (ODA) had no significant impact on the total health expenditure, it had an elasticity of 0.138 against the public spending on health. Farag *et al*. (2009) found that for a 1% increase in the health-specific ODA, the government health expenditure reduced by 0.027% in the upper middle-income countries, 0.04-0.09% in lower middle-income countries, and 0.14- 0.19% in low-income countries.

Regarding financing, few empirical studies have found that the extent to which the healthcare expenditure is financed by the government has a relationship with the health expenditure levels (Culyer1988; Hitiris and Posnett 1992; Van der Gaag and Stimac 2008). The health expenditure differences between tax-based versus social-insurance based systems have been examined in OECD and eastern European and central Asian (ECA) countries (Wagstaff and Bank 2009; Wagstaff and Moreno-Serra 2009), the OECD study found that the health expenditure per capita was higher in countries equipped with a social health insurance mechanism, but the ECA study suggested that the per capita government health expenditure was higher in countries having social health insurance compared to those relied solely on the general taxation.

# 3. Materials and Methods

## 3.1. Estimation Method: Bayesian panel data analysis

Based on a combination of hierarchical prior modeling and Markov Chain Monte Carlo (MCMC) simulation methods, the Bayesian approach provides additional tools by providing a complete inferential tool-kit for a variety of panel data models for those carrying out health-care evaluations rather than replacing their traditional methods. It is interesting to know that the approaches are capable of tackling estimations and model comparison questions in situations quite challenging by other means because the implementation of the Bayesian paradigm is inextricably tied to MCMC methods (Chib 1995) that let us draw samples from a distribution even if we cannot compute it. It can be used to sample from the posterior distribution (what we wish to know) over parameters.

Effort has been made in this paper to propose a Bayesian dynamic panel model by describing several innovative dynamic panel data models that allow variations in slope coefficients both across time and cross-sectional units particularly when the objective is to use panel data models to forecast purposes. All models are finally developed in a

Bayesian framework as the traditional sampling-theory estimators are difficult to compute and they may behave erratically in finite samples. Sampling-theory estimators cannot be used with dynamic panel data models with random coefficients because the widely used Arellano-Bond (1991) Generalized Method of Moments (GMM) estimator assumes fixed slope coefficients. Assaf and Tsionas (2019) state that "this is an important handicap which limits the scope of sampling-theory estimators in dynamic panel data models. Bayesian procedures are more straightforward to apply in dynamic models as lagged dependent variables do not create new problems in terms of estimation for the Bayesian approach". In addition, when the Arellano-Bond instruments are weak, using Arellano-Bond GMM estimator is problematic and the sampling behavior of GMM can be erratic and unreliable.

Selecting an appropriate model is considerably simplified by taking a Bayesian perspective on model uncertainty for static panel data models proposed in the spatial econometrics literature.

The Bayesian solution to the model choice is to calculate posterior model probabilities associated with each model and use them to produce a model specification that averages over the set of models under consideration. This way, the model uncertainty about its correct specifications is formally incorporated into the statistical inference problem at hand.

The Bayes' theorem provides the machinery for updating a probability distribution with new data. If $\rho(\theta)$ and $\rho(\theta \mid Y)$ are the probability distributions for a quantity $\theta$ before considering new data (the prior) and for incorporating new data Y (the posterior), respectively, $\rho(\theta \mid Y)$ can be found by multiplying the prior by $\rho(Y \mid \theta)$ (the likelihood function) and scaling by $\rho(Y)$; the probability of observing the data is then:

$$\rho(\theta \mid Y) = \frac{\rho(\theta) \times \rho(Y \mid \theta)}{\rho(Y)}. (1)$$

For most applications, it is sufficient to represent the posterior as proportional to the prior times the likelihood omitting $\rho$ (Y):

$$p(\theta \mid Y) \propto p(\theta) \times p(Y \mid \theta). (2)$$

Keeping Y fixed and varying $\theta$, the likelihood function $p(Y \mid \theta)$ can be used to describe the relative likelihood of different values of $\theta$ given the evidence represented by Y. Parameter sets with higher values of $p(Y \mid \theta)$ are more consistent with data Y a feature that allows us to assess the extent to which the evidence supports one parameter set compared with another. Bayesian methods focus on estimating the posterior distribution $p(\theta \mid Y)$ and, hence, incorporate evidence from both prior and likelihood. Estimating the posterior distribution can be complicated when calibrating health policy models, but the basic components are: 1. prior distributions representing evidence on model parameters, 2. a likelihood function relating modeled outcomes to empirical data and 3. the model itself, which translates model parameters into modeled outcomes.

The models described above have been mainly applied in a frequentist framework. But, it is also possible to build models with the same theoretical characteristics using the Bayesian statistics according to the convention of which the precision (inverse of the variance) not the variance, is used throughout the text. The normal distribution is therefore given as N∼ (mean, precision) instead of N∼ (mean, variance).

### 3.2. Constructing model, selecting variables, determining sources of data

The WHO NHA and WDI were the sources that provided the data for the present paper. The panel consists of 71 reporting countries (Ni = 71) dividing the main sample into very high, high, and middle-low sub-groups based on the per capita income. The considered period for which the yearly data are available (T = 14) is 2006-2018, and the oil-exporting countries are listed in (Table 1).

Table 1. List of oil-exporting countries

| Very high income (1-0.8) | High income (0.7) | Middle and lower income (0.6- 0.3) |
|---|---|---|
| Argentina, Australia, Bahrain Barbados, Brunei, Canada, Czech, Denmark, Estonia, Germany, Greece, Ireland, Italy, Kazakhstan, Kuwait, Lithuania, Malaysia, Netherlands, New Zealand, Norway, Oman, Poland, Qatar, Romania, Russia, Saudi Arabia, Slovakia, United Arab Emirates, United Kingdom, United States | Albania, Algeria, Azerbaijan, Belize, Brazil, Colombia, Cuba, Iran, China, Ecuador, Gabon, Peru Georgia, Libya, Tunisia, Mexico, Ivory coast Mongolia, Suriname, Thailand, Trinidad and Tobago, Turkmenistan, Venezuela. | Angola, Bolivia, Cameroon, Chad, Egypt, Equatorial, Iraq, Yemen, Syria, Mauritania, Guinea, Nigeria, Papua, New guinea, South Sudan, Sudan, Vietnam, Philippines, Guatemala, Indonesia. |

The total health expense function has the following form:

THCE = *f* (GDP, Employment, GNI, Population, Life expectancy, Inflation, Fertility, Foreign direct investment, Death rate, Birth rate, HDI)

$$HCE_{VHt} = \beta_0 + \beta_1 GDP_t + \beta_2 GNI_t + \beta_3 HDI_t + \beta_4 EMP_t + \beta_5 BR_t + \beta_6 DR_t + \beta_7 FDI_t + \beta_8 FRT_t + \beta_9 CPI_t + \beta_{10} LE_t + \beta_{11} POP_t + \varepsilon_t$$

$$HCE_{Ht} = \beta_0 + \beta_1 GDP_t + \beta_2 GNI_t + \beta_3 HDI_t + \beta_4 EMP_t + \beta_5 BR_t + \beta_6 DR_t + \beta_7 FDI_t + \beta_8 FRT_t + \beta_9 CPI_t + \beta_{10} LE_t + \beta_{11} POP_t + \varepsilon_t$$

Here, (t) is the period between 2006 and 2018.

According to Aboubacar and Xu (2017); Giammanco and Gitto (2019), foreign direct investments are vital determinants of the economic growth.

Regression models constructed for the analyses of the Bayesian dynamic panel models are as follows:

$$HCE_{M-L} = \beta_0 + \beta_1 GDP_t + \beta_2 GNI_t + \beta_3 HDI_t + \beta_4 EMP_t + \beta_5 BR_t + \beta_6 DR_t + \beta_7 FDI_t + \beta_8 FRT_t + \beta_9 CPI_t + \beta_{10} LE_t + \beta_{11} POP_t + \varepsilon_t$$

Eqs. 1 - 3 show the regression models for very high-, high- and middle-low-income regions, respectively. In this paper, based on some earlier study (Reifels *et al*. 2018) the dependent variable was the HCE while income, employment, GNI per capita, human development index, birth rate, death rate, foreign direct investment, fertility rate, inflation, life expectancy, total population, were the independent variables (Table 2).

Table 2. Variables' definitions

| Type | Name | Definition |
|---|---|---|
| Dependent | HCE | Current health expenditure per capita, PPP (current international $). |
| Independent | EMP | Employment to population ratio, total (%) |
| | GDP | GDP growth (annual %) aggregates are based on the American dollar (constant 2010) |
| | GNI | GNI = Gross national income/mid-year population |
| | HDI | HDI was defined to conclude that people (and their capabilities) are the final criteria to evaluate a country's development not only its economic growth. |
| | BR | Crude birth rate (per 1,000 people per 1,000 midyear population) indicates the No. of live births |
| | DR | Crude death rate (per 1,000 people per 1,000 midyear population) indicates the No. of deaths |
| | FDI | Foreign direct investment, net (BoP, current US$), Data are in current U.S. dollars. |
| | FRT | Fertility rate |
| | CPI | Consumer price inflation (annual %), at-birth life expectancy, |
| | LE | Life expectancy at birth, total (years) |
| | pop | Total population (mid-year estimates) includes all residing people (whether legal status or citizenship). |

The specified model's summary, especially useful for complex models with numerous parameters/hyper-parameters, is first provided by bayesmh. The suggestion is to first specify the dry-run option to provide only a model summary, with no estimations, to verify the model specifications and then proceed with estimations. (Table 3) shows the variables' summary characteristics in the regions of all the three groups.

Table 3.a. Summary statistics for very high-income countries

| Variables | Mean | SD | Skew | Kurtosis | Variance |
|---|---|---|---|---|---|
| **HCE** | 155.7 | 115.2 | .132 | 1. 70 | 13278.1 |
| **EMP** | 59.69 | 9.04 | .736 | 4.17 | 81.7 |
| **GDP** | 209.49 | 120.72 | .00003 | 1.7986 | 14575.65 |
| **GNI** | 210.5 | 121.38 | 0 | 1.799 | 14735 |
| **HDI** | .854 | .052 | -.004 | 1.96 | .0027 |

| | | | | | |
|---|---|---|---|---|---|
| **BR** | 83.88333 | 73.41723 | .5690375 | 1.915284 | 5390.089 |
| **Death** | 119.0595 | 80.66347 | .048985 | 1.557342 | 6506.595 |
| **FDI** | 200.0238 | 111.0051 | -.0530498 | 1.89621 | 12322.12 |
| **FRT** | 100.5214 | 77.37768 | .4109231 | 1.943483 | 5987.305 |
| **CPI** | 193.2643 | 118.7027 | .0602911 | 1.747648 | 14090.32 |
| **LE** | 174.3 | 112.35 | -.010 | 1.742 | 12622.6 |
| **pop** | 3.26e+07 | 6.02e+07 | 3.53 | 16.12 | 3.63e+15 |

Table 3.b. Summary statistics for high-income countries

| Variables | Mean | SD | Skew | Kurtosis | Variance |
|---|---|---|---|---|---|
| HCE | 114.6 | 87.2 | .1611027 | 1.69 | 7603.6 |
| EMP | 55.377 | 10.34 | -.2661721 | 2.22 | 106.90 |
| GDP | 157. | 92.2 | .0252141 | 1.78 | 8501.6 |
| **GNI** | 154.59 | 92.9513 | .005 | 1.79 | 8639.9 |
| HDI | 75.96 | 33.89 | -.340 | 2.35 | 1148.2 |
| BR | 135.2 | 89.07 | .052 | 1.75 | 7934.6 |
| Death | 130.5 | 84.01 | .018 | 1.79 | 7058.4 |
| FDI | 151.36 | 80.15 | -.300 | 1.73 | 6424.8 |
| FRT | 123.1 | 82.3 | .1107 | 1.79 | 6780.01 |
| CPI | 99.98 | 80.66 | .309 | 1.698 | 6505.8 |
| LE | 140.29 | 91.85 | .039 | 1.76 | 8436.4 |
| pop | 8.87e+07 | 2.73e+08 | 4.28 | 19.9 | 7.44e+16 |

Table 3.c. Summary statistics for middle-low-income countries

| Variables | Mean | SD | Variance | Skew | Kurtosis |
|---|---|---|---|---|---|
| HCE | 79.96825 | 65.45068 | 4283.792 | .2446986 | 1.687855 |
| EMP | 55.71118 | 13.30702 | 177.0768 | -.0673363 | 1.65972 |
| GDP | 112.754 | 69.66221 | 4852.824 | .1084659 | 1.731328 |
| GNI | 105.4563 | 67.55398 | 4563.54 | -.0371045 | 1.739345 |
| HDI | 93.8254 | 51.67506 | 2670.312 | -.126928 | 1.814115 |
| BR | 109.3651 | 71.59549 | 5125.914 | .0469846 | 1.758706 |
| Death | 109.0913 | 71.05956 | 5049.462 | .0406583 | 1.772826 |
| FDI | 110.3452 | 54.5128 | 2971.645 | -.4813895 | 1.905857 |
| FRT | 108.4167 | 70.69561 | 4997.87 | .0418686 | 1.764604 |

| | | | | | |
|---|---|---|---|---|---|
| CPI | 105.9405 | 70.70093 | 4998.622 | .0826545 | 1.728531 |
| LE | 109.7103 | 71.37159 | 5093.904 | .0234923 | 1.750748 |
| pop | 5.01e+07 | 6.41e+07 | 4.11e+15 | 1.90657 | 5.905839 |

Where the differences in the center and spread of the data for each group are evident. Group three has a lower mean HCE (79.96) and less variation than the other two concluding that the first group countries (155.7) are almost twice as large as the third group countries.

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# 4. Results

## 4.1. Empirical test: Unit Root Test

Table 4 lists the panel unit root test results to see if HCE/other variables' changes are stationary

Table 4. Panel unit root test results

| Variables | Unit root test | |
|---|---|---|
| | Statistic | p-value |
| HCE | 23.1369 | 0.0000 |
| EMP | 44.5488 | 0.0000 |
| GDP | 10.0588 | 0.0000 |
| GNI | 28.8146 | 0.0000 |
| HDI | 57.7218 | 0.0000 |
| BR | 14.2411 | 0.0000 |
| Death | 14.3449 | 0.0000 |
| FDI | 1.6895 | 0.0456 |
| FRT | 16.7168 | 0.0000 |
| CPI | 13.6988 | 0.0000 |
| LE | 1.8033 | 0.0357 |
| pop | 54.8040 | 0.0000 |

Since Levin-Lin-Chu's stationarity test results (Table 4) show that the studied variables are stationary, they can be used for model estimation with no concerns over erroneous inferences about the extent of the inter-variable relationships.

## 4.2. Quantile regression

The dependent variable's median is estimated by the median regression based on those of the independent variables (similar to the least-square regression).

Table 5. Quantile regression

| variable | Group one | | Group two | | Group three | |
|---|---|---|---|---|---|---|
| | Coefficient | Standard error | Coefficient | Standard error | Coefficient | Standard error |
| EMP | 1.125868 | .5398262 | .3924509 | .8446074 | -.2922056 | .5180848 |
| GDP | -.0006489 | .0326784 | -.0054583 | .0908229 | .2187067 | .1046958 |
| GNI | -.0756993 | .0336388 | .10841 | .0920312 | .1576377 | .1028128 |
| HDI | 722.1431 | 118.4728 | .6678767 | .2837988 | -.1643327 | .221049 |
| BR | .1771057 | .0649516 | .0724609 | .2186816 | 1.612578 | .9032371 |
| DR | .2812813 | .057803 | .2655403 | .1118187 | .1569563 | .1096427 |
| FDI | .1042412 | .0358676 | .1323918 | .1084088 | .1145196 | .1173098 |
| FRT | .2046338 | .0726457 | .5161009 | .2326106 | -1.316659 | .9273599 |
| CPI | .0040328 | .032838 | -.0476261 | .1065401 | .1466725 | .0972364 |
| LE | .3319106 | .0524727 | .0793868 | .0976756 | .0207063 | .1453451 |
| Pop | 3.62e-07 | 6.42e-08 | 3.15e-08 | 3.32e-08 | 4.78e-09 | 1.16e-07 |
| Cons | -681.2578 | 102.038 | -105.6577 | 67.14106 | -20.43733 | 44.70877 |

Results in (Table 5) show, as expected, the coefficients in all three groups are different. In the first (very high-income), the raw mortality, inflation and life expectancy have positive significant effects on healthcare expenditures, effects of GNI/GDP growth rate are significantly negative and effect of the probability value is insignificant. In the second (high-income), GDP and CPI have negative and other variables have positive significant effects on healthcare expenditures. And, in the third (middle-low-income), the GDP growth rate in terms of per capita consumption (income) has a positive significant effect, but HDI and fertility rate have negative significant effects on the healthcare expenditure. The heterogeneity in inequality across the three country groups suggests that the healthimprovement pace/pattern has changed over the past decade.

### 4.3. Bayesian linear regression

Bayesian models have several regression coefficient parameters including {HCE: EMP}, {HCE: GDP}, {HCE: GNI}, {HCE:GNI}, {HCE:HDI}, {HCE: BR}, {HCE:DR}, {HCE:FDI}, {HCE:FRT}, {HCE: CPI}, {HCE:LE}, {HCE:Pop} and {HCE} and {sigma2} which is a positive parameter that shows the error term variance. In the models' summary, one column shows the parameters' mean of marginal posterior distributions and the next one show estimates of the posterior standard deviations (marginal posterior distribution's standard deviations). Since the MCMC standard errors show accuracy of the posterior mean estimates, these numbers should be smaller than the parameters' scales and should decrease with an increase in the MCMC sample size.

Table 6. Bayesian linear regression

| Group | variable | Average | Standard deviation | MCSE | Media | Equal-tailed | |
|---|---|---|---|---|---|---|---|
| GROUP 1 | HCE | | | | | | |
| | EMP | -.0040365 | .3982386 | .053169 | -.0527058 | -.6273692 | .4333489 |
| | GDP | -.7129835 | 1.146554 | .160399 | -.2223165 | -2.122688 | .1142045 |
| | GNI | -.2801317 | .1771058 | .02379 | -.3072974 | -.4622274 | -.0570343 |
| | HDI | 222.5988 | 41.19979 | 5.91899 | 213.0006 | 186.9175 | 267.7873 |
| | BR | .7348188 | 2.004782 | .252185 | .1484719 | -1.090433 | 3.092481 |
| | DR | .6063574 | .7388779 | .068334 | .2527568 | .0660521 | 1.5393 |
| | FDI | .1797639 | .2109592 | .025775 | .0883539 | .0218494 | .5050771 |
| | FRT | .2382113 | .2847293 | .031974 | .2005581 | -.083344 | .5849781 |
| | CPI | .8970045 | .6975743 | .081068 | 1.034663 | .1351894 | 1.559461 |
| | LE | -.5758072 | 1.232544 | .119686 | .0165167 | -2.056175 | .2888654 |
| | Pop | 7.68e-07 | 5.56e-07 | 1.6e-08 | 6.28e-07 | 2.20e-07 | 1.82e-06 |
| | cons | -184.751 | 11.22954 | .983105 | -181.8525 | -197.2704 | -175.2442 |
| | Sigma2 | 78641.46 | 87392.88 | 1802.48 | 50429.65 | 9201.205 | 200525 |

| | | |
|---|---|---|
| | | |
| | Iterations = 12,500 Avg acceptance rate = .5189<br>Burn-in = 2,500 Avg efficiency: min = .001257<br>Sample size = 10,000 Max Gelman-Rubin Rc = 430.7<br>Avg log marginal-likelihood = -3247.2919 | |
| **Group2** | HCE | |
| | EMP | .8688781 1.674636 .261878 .6375569 -.6785904 2.650003 |
| | GDP | -.2806066 .3424093 .05242 -.2010949 -.6558798 .0151776 |
| | GNI | -.3487084 .8175053 .118887 .0536916 -1.289546 .1977638 |
| | HDI | .2567395 .1452831 .022882 .2363923 .1225707 .4118877 |
| | BR | -.3560649 .5445635 .084005 -.1586669 -.9722432 .063689 |
| | DR | .8239525 2.385315 .367106 .172242 -1.171117 3.467824 |
| | FDI | .4977644 .822606 .122927 .089442 -.042554 1.444752 |
| | FRT | 1.415099 1.208454 .189006 1.235051 .3065198 2.70877 |
| | CPI | .0148038 .1413493 .022041 .0169191 -.1280907 .1555664 |
| | LE | -.0582515 .3239989 .050076 .0935282 -.4324011 .1630612 |
| | Pop | -2.22e-08 2.17e-07 2.8e-09 2.30e-08 -3.54e-07 2.37e-07 |
| | cons | -54.34079 5.953749 .930042 -52.92904 -60.87731 -49.21922 |
| | Sigma2 | 73380.72 66825.04 1304.56 76600.92 5831.525 166394.9 |
| | | |
| **Gr** | HCE | |

| | | |
|---|---|---|
| | EMP | -.2637537 1.235823 .144858 -.5199044 -1.448546 1.097581 |
| | GDP | .1525261 .0974146 .011899 .1536423 .0281838 .3808184 |
| | GNI | -.2978723 .7130556 .109661 .0349299 -1.242886 .235377 |
| | HDI | -.6082449 .4847079 .05864 -.8405053 -1.051511 -.0604602 |
| | BR | -1.038986 2.202915 .255704 -.4452095 -3.515294 .8205937 |
| | DR | .1811644 1.564642 .197061 .0425371 -1.390739 1.881549 |
| | FDI | .8335125 1.262782 .166329 .1608312 .0560326 2.492932 |
| | FRT | .8786956 1.204339 .143855 1.496417 -.5048446 1.739663 |
| | CPI | .5523743 .6678081 .076871 .1821002 .1476602 1.547045 |
| | LE | -.2385091 .4825423 .057063 -.0917397 -.9408266 .165316 |
| | Pop | 2.28e-07 5.77e-07 2.7e-08 5.99e-08 -5.84e-07 1.08e-06 |
| | cons | 12.16517 2.913742 .340708 11.9965 9.271456 15.14715 |
| | Sigma2 | 36157.01 36142.98 735.363 29930.4 3165.323 85700.4 |

According to(Table 6) which shows the mean of the posterior distribution, the MCSE accuracy is similar to our simulations; our preference is a zero value for which the needed MCMC iterations are quite large; our results were correct and precise (about 1 decimal place) after about 10,000 iterations. Although it is satisfying, we would need more MCMC samples if we wished more accuracy

## 4.4. Efficiency summary

Table 7. Efficiency summary

| variable | ESS Efficiency | ESS Efficiency | ESS Efficiency |
|---|---|---|---|
| HCE | | | |
| EMP | 56.10 0.0019 | 40.89 0.0014 | 72.78 0.0024 |
| GDP | 51.10 0.0017 | 42.67 0.0014 | 67.02 0.0022 |
| GNI | 55.42 0.0018 | 47.28 0.0016 | 42.28 0.0014 |
| HDI | 48.45 0.0016 | 40.31 0.0013 | 68.32 0.0023 |
| BR | 63.20 0.0021 | 42.02 0.0014 | 74.22 0.0025 |
| DR | 116.92 0.0039 | 42.22 0.0014 | 63.04 0.0021 |
| FDI | 66.99 0.0022 | 44.78 0.0015 | 57.64 0.0019 |
| FRT | 79.30 0.0026 | 40.88 0.0014 | 70.09 0.0023 |
| CPI | 74.04 0.0025 | 41.13 0.0014 | 75.47 0.0025 |
| LE | 106.05 0.0035 | 41.86 0.0014 | 71.51 0.0024 |
| Pop | 1155.75 0.0385 | 5972.61 0.1991 | 471.57 0.0157 |
| cons | 130.47 0.0043 | 40.98 0.0014 | 73.14 0.0024 |
| Sigma2 | 2350.77 0.0784 | 2623.93 0.0875 | 2415.71 0.0805 |

The ESS estimates-MCMC sample size dependence is important; the closer they are the less correlated is the latter and the more accurate are the former. Care should be taken when efficiencies are below 1%.

## 4.5. The Gelman–Rubin convergence diagnostic

It is important to verify the MCMC convergence before interpreting the results. To this end, the Gelman–Rubin diagnostic compares inter-chain and intra-chain variances by analyzing multiple Markov chains differences to evaluate the convergence; high differences mean non-convergence.

Table 8. Gelman-Rubin convergence

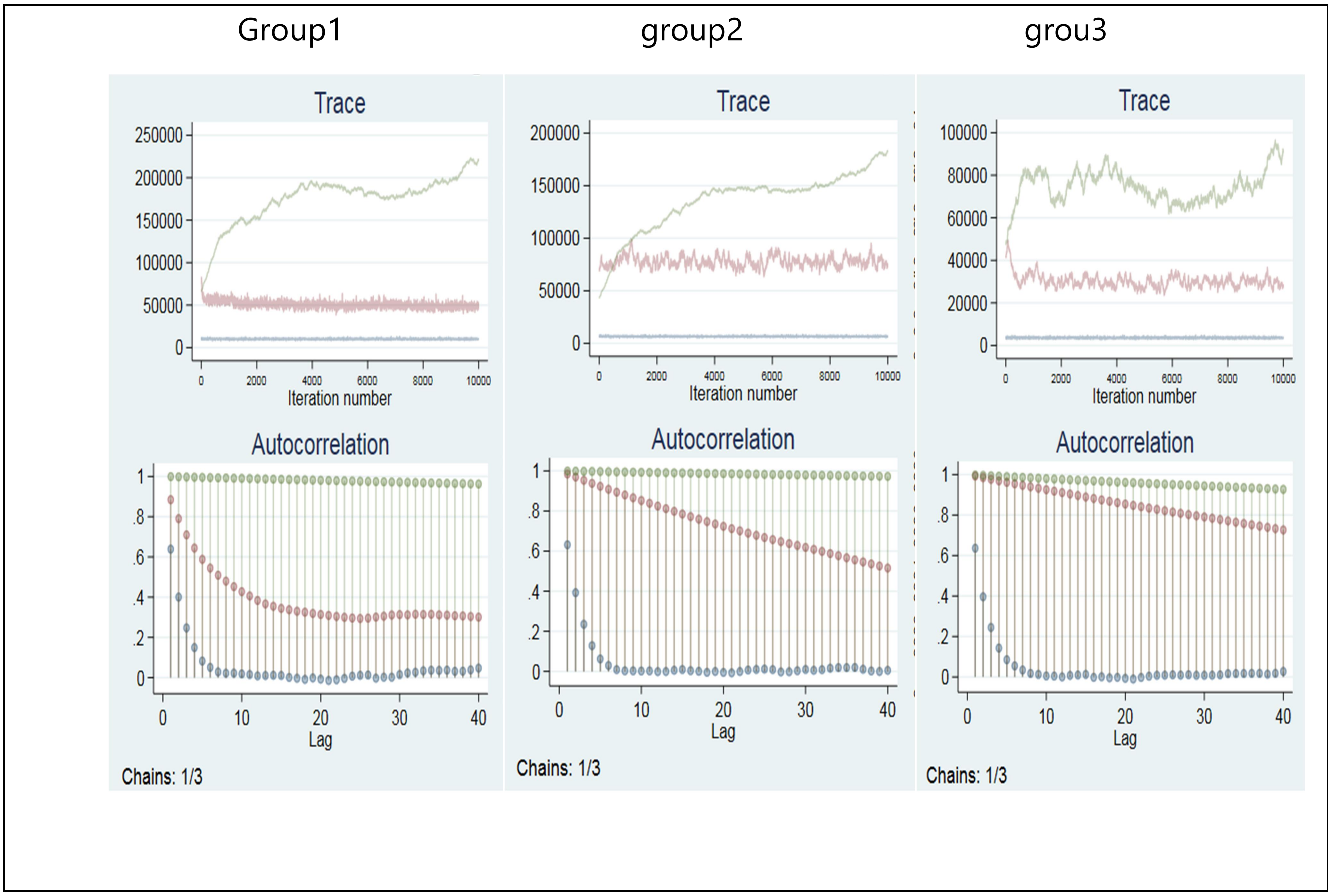
| variable | Group one RC | Group two RC | Group three RC |
|---|---|---|---|
| HCE | | | |
| EMP | 7.018332 | 2316.524 | 41.01594 |
| GDP | 17.02431 | 849.1851 | 1.601032 |
| GNI | 8.993579 | 404.7391 | 16.6058 |
| HDI | 992.7189 | 402.5145 | 5.787253 |
| BR | 41.26825 | 408.1224 | 93.92373 |
| DR | 34.23148 | 2839.673 | 47.09232 |
| FDI | 5.40044 | 1566.633 | 16.15871 |
| FRT | 13.15112 | 799.3075 | 17.44434 |
| CPI | 23.79587 | 772.0606 | 9.009125 |
| LE | 39.29125 | 495.619 | 6.982553 |
| Pop | 3.518541 | 6.067099 | 4.213566 |
| cons | 286.2141 | 5511.181 | 45.03762 |
| sigma2 | 7.889621 | 5.911349 | 11.20345 |

In (Table 8), RC exceeds 1 for each model meaning non-convergence, but since {var}'s value is less than the maximum Gelman Rubin for each model {sigma2} has convergence problems.

## 4.6. Bayes-graph diagnostics {var}

The MCMC convergence is often diagnosed by multiple chains because its variance has very poor mixing and high autocorrelation for each model.

Fig 3. Bayes-graph diagnostics {var}



As shown, the trace plots cannot converge, separation in their chains is clear, and all three chains are, as expected, distributed differently. Solving convergence problems requires clearly defined rules, but still there is none.

## 5. Discussion

Since organization and financing of healthcare systems are different in the three country groups, it is important to know how the economic conditions and income inequality affect the international population health. In general, our results indicate that the highest (155.7) and the lowest (79.96) mean healthcare expenditures were reported in the first group countries and third group countries, respectively.

These results are consistent with those of Grossman (1972); Karl (1997); Smith (2004); Wang (2011); Bloom *et al*. (2015). It is the policy effectiveness that determines the GDP effects on the healthcare spending, but since researchers do not all agree on this, it may be concluded that such expenditures are mostly managed by the private sector and people's direct payments. The increased total expenditure is a great concern in many developing countries as regards the direct payments, especially in under-developed countries.

in the countries studied Since health care is a must not a luxury good, FDI has placed statistically significant and positive emphasis on the related expenditures. The foreign direct investment appears to be a significant determinant of economic growth (Giammanco and Gitto 2019).
Besides, since good health is a major human-capital component, it attracts the FDI inflows, which "by themselves, create spillover efficiency benefits for host economies and offer an additional source of social benefit to an overall benefit-cost appraisal of government health care expenditures" (Globerman and Shapiro 2002).
As population increases, the demand for healthcare services increases, and as a result, healthcare expenditure is increased. This supports the findings of Luis Currais. The results show that healthcare expenditure significantly improves the life expectancy, in accordance with the findings of Novignon *et al.* (2012). Increases in the mortality rates are in direct relationship with the increases in the share of healthcare expenditures. This is consistent with Berger and Messer 2002, but inconsistent with Novignon *et al*. 2012; Rahman *et al.* 2018. This finding can be attributed to the fact that although has greatly expanded health insurance coverage, financial protection remains insufficient. Those who have found, so far, the cross-country convergence in health-care expenditures include Barros (1998); Hitiris and Nixon (2001); Narayan (2007).
Regulating access to the GDP share of the health expenditures and defining the medical care output grow the divergence in the health care due, mainly, to the political factors rather than policy-related features. De Rynck and Dezeure (2006); Panopoulou and Pantelidis (2012) state that governments play a vital role in taking advantage of the opportunities to trigger and support the changes.

An increase in the employed-to-unemployed ratio increases the healthcare expenditures and the level of the human development is directly related to the outcomes of the health system in the first and second country groups. Åhs *et al*. (2012) showed that there is a higher use of care among the unemployed than among theemployed, although the findings on the relationship between unemployment and healthcare use are not certain.

Correlation analyses results show that the HDI and health care expenditure correlate strongly positively revealing that high-income countries, with higher healthcare financial allocations, report strong positive health-system results (Alin and Marieta 2011).Evidences show that an increase in the GNI per capita reduces the illness and mortality rates leading to an increase in the elderly population. However, the trend varies positively across the world; improvements are faster in some countries and slower in some (Jalal and Khan 2015).

So, the world needs to consider this demographic transition and governments need to track the trend of the economic variations and help health investments to be as large as possible for non-communicable disease treatments and pharmacological innovations.

## 6. Conclusions and Recommendations

Different countries have reached universal health through highly different paths and systems. There had always been differences between low and high-income countries in the speed of recovery. The speed of recovery has always been different due, partly, to the type of the health system, healthcare financing/provisions, and percent GDP invested in health. This paper assessed the expenditure capacity of different health systems to grasp the institutional context of the healthcare and explain health policies in different oil exporting countries by analyzing the institutional framework of their health systems where health policies are shaped by healthcare institutions. It used the 2006-2018 panel data of 71 oil exporting countries to study and compare the effects of wealth on health expenditures based on the quantile regression and Bayesian method with the MCMC technique. These countries were divided into very high-, high- and middle-to-lower-income countries based on the human development index (HDI); empirical evidences showed that coefficients were different in all three groups. Supporting the existence of divergent per capita healthcare expenditure, results of this study identified what caused the divergent behavior in the three groups.

Designing financial incentives through Improving insurance plans, providing benefit packages, applying better expense control strategies and so on are what policy-makers should focus on, and primary care, with more emphasis on intensive care, is what healthcare systems should pay attention to in these countries.

Policies should improve the financial protection, relieve the economic burden and alleviate the CHE inequality among elderly households. If health spending grows using some financing mechanisms (e.g., pooled), the healthcare system will be promoted efficiently. These countries need to adopt public policies that do not rely on direct spending and should improve institutes that address, through pooled funding management, the health expense sustainability/equity/efficiency.

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