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Impact of Energy Consumption, GDP & Fiscal Deficit on Public Health Expenditure in India: An ARDL Bounds Testing Approach

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Abstract

The purpose of this paper is to explore the impact of energy consumption (EC), fiscal deficit (FD) & gross domestic product (GDP) on public health expenditure (PHE) in the country. The data for this study is taken for the time period 1971-2011. Autoregressive distributed lag (ARDL) has been used to test for presence of cointegration among the variables while vector error correction model (VECM) has been employed to determine the direction of causality. The results reveal the presence of long run causal relationship between EC, FD & GDP and PHE while in the short run; only GDP was found to be significantly causally related to health expenditure. There are clear policy implications of our results. There has to be a reduction in the energy that we import from abroad as lot of our revenue goes into these imports. Similarly, the government will have to move towards deregulating the oil price regime and better targeting of subsidies to reduce the burden on the fiscal situation of the country. Also, the indigenous non-renewable resources should be developed as substitutes for oil. These steps will save government finances that can be invested in improving the situation of healthcare in the country.

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Keywords: Energy Consumption; Fiscal Deficit; GDP; Health Expenditure; Causality

1. Main text

There is an increasing recognition in the health community across the world that public health spending constitutes an important source of health finance in developing and underdeveloped countries and is crucial to achieve Millennium Development Goals in the areas of health and poverty [1-4]. The majority of the countries falling in the low and middle income bracket have low level of per capita income and correspondingly widespread poverty which has led to adverse health outcomes in majority of these countries. Considering the fact that the greater part of the population is still poor in these nations, there is an increasing need to establish quality public health infrastructure and improve the existing one if the health of the population is to be improved. This can however only be achieved if respective governments allot higher proportion of their revenue towards public health. Though, the appropriate allocation of funds

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can only be achieved if the finances of the government and the condition of the economy are in a good shape.

Number of studies has been conducted in order to determine the factors related to the state of the economy which influences Public Health Expenditure (PHE). The first factor that has been looked at is the GDP, which has been found to be strongly and positively correlated with national health expenditure [5-7]. This follows simply from the fact that if the economy is doing well and the future looks bright, then the government will most probably tend to spend higher on social infrastructure than in the case where the finances are burdened and the outlook looks bleak. Another variable related to the state of the economy and more typically to the condition of the government finances i.e. Government Deficit has also been found to be associated with public spending on health [8].

In a country like India, government deficit is highly related to energy consumption because of the confluence of multiple factors like high consumption of oil, low domestic production and thereby high import of crude oil and government control over the price of petroleum products namely petrol, diesel, kerosene and LPG. According to the information available from the US Energy Information Administration, India was the fourth biggest consumer as well as net importer of oil in the world in 2012 consuming 3450 thousand barrels of oil per day and importing 2460 barrels of oil per day which amounts to an import of almost 71% of the total oil requirement of the country per day. This not only leads to a significant outgo of our foreign exchange but also exposes us to the volatility in international oil price. Also, except for the past one to one-half years when the oil price regime has been liberalised a bit and that too only for petrol and diesel, the downstream oil companies have been required to sell petroleum products below their cost thus leading to huge losses to these companies which the government is forced to partially compensate through its own exchequer. This imposes a burden on the fiscal situation of the country due to which the amount of extra funds that could possibly have been there with the government for its social needs need to be diverted towards maintaining the appropriate fiscal balance.

Against this backdrop, this paper makes an attempt to understand the impact of GDP, Government Deficit and Energy Consumption on Public Health Expenditure. We empirically test the hypothesis that GDP, Government Deficit and Energy Consumption have had a significant influence on government's expenditure on public health.

2. Data & Variables

Annual data for the years 1971-2011 has been used for our investigation. Fiscal Deficit (FD) has been used as an indicator for measuring government deficit. Energy Consumption (EC) is measured as kilotonne (kt) of oil equivalent. Public Health Expenditure as a percent of GDP (PHEG) has been taken as a variable to look at the total government expenditure on health. The data on GDP & Energy consumption has been taken from World Development Indicators while the data on Fiscal deficit & Public Health Expenditure is taken from RBI & Economic Surveys respectively.

3. Methodology

3.1 Empirical model

The empirical model below illustrates the relationship between public health expenditure, fiscal deficit, GDP & energy consumption:

PHEG= f (EC, FD, GDP)

We have employed the ARDL (Autoregressive Distributed Lag) bounds testing approach developed by Pesaran, Shin & Smith (2001)[9] to ascertain the causal relationship between PHEG, EC, GDP & FD. The major advantage of using an ARDL approach is that it can be used even in cases when different variables have different orders of integration as is the case with our variables which is not possible with traditional cointegration techniques like Johansen cointegration test (1988)[10] and Engle & Granger (1987)[11]. Also, ARDL can estimate the cointegration equation with very small number of sample cases [12] while Johansen test requires a large sample size for correct estimation. The ARDL model involves two steps. The first step involves determining whether a long term relationship exists between the variables under study and the second step is to estimate the short run as well as long run causality.

To determine the presence or absence of long term relationship among the variables, the idea of cointegration is employed in the study. The presence of cointegration among the variables provides an evidence of the presence of long run association. The ARDL bounds testing approach towards determination of cointegration is based on an estimate of unrestricted error correction model. To examine the cointegration between public health expenditure, gross domestic product, energy consumption and fiscal deficit, the following ARDL model is evaluated:

$$\Delta PHEG_t = \beta_{0PHE} + \sum_{p=1}^{a} \gamma_{pPHE}\, \Delta PHE_{t-p} + \sum_{q=1}^{b} \gamma_{qPHE}\, \Delta FD_{t-q} + \sum_{r=1}^{c} \gamma_{rPHE}\, \Delta GDP_{t-r} + \sum_{s=1}^{d} \gamma_{sPHE}\, \Delta EC_{t-s}$$

$$+ \lambda_{1PHE} PHE_{t-1} + \lambda_{2PHE} FD_{t-1} + \lambda_{3PHE} GDP_{t-1} + \lambda_{4PHE} EC_{t-1} + \varepsilon_t$$

Δ represents change; β_{0PHE} is the drift component in the equation; ε_t is white noise; γ is the short run coefficient & λ is the corresponding long run multiplier of the underlying ARDL model.

The null hypothesis of "no cointegration" is tested by using the F-statistic value by comparing them with the critical bound values as given by Pesaran et al. (2001)[9]. If the F-statistics is greater than the upper critical bound value, then there null hypothesis of no cointegration is rejected and there is a definite long-run association between the variables. Correspondingly, if the value of the F-statistics is below the lower critical bound, then the null hypothesis is accepted. However, if the F- value falls between the lower and the upper critical bound, then no definite conclusion can be made without knowing the order of integration of the variables. If all the variables are integrated of order one i.e. I(1), then the decision is made on the basis of the upper bound value while if the order of integration is zero (i.e. at level), the decision is made on the lower critical bound.

The second step involves determining the short term and long term causality. To estimate the long term and short term causality among the variables of our interest, the following would be the error correction model:

$$\Delta PHEG_t = \varphi_0 + \sum_{j=1}^{p} \varphi_{1PHEj}\, \Delta PHE_{t-j} + \sum_{j=0}^{q} \varphi_{2PHEj}\, \Delta FD_{t-j} + \sum_{j=0}^{r} \varphi_{3PHEj}\, \Delta GDP_{t-j} + \sum_{j=0}^{s} \varphi_{4PHEj}\, \Delta EC_{t-j}$$

$$+ \eta_{PHE} ECM_{t-1} + \phi_t$$

Here η_{PHE} is the speed of adjustment parameter and ECM_{t-1} is the error correction term with lag.

Various diagnostic and stability tests were also conducted to test for Goodness of fit, serial correlation, heteroskedasticity. Stability was examined by employing the CUSUM test (cumulative sum of recursive residuals).

4. Results and Discussion

Before proceeding with the ARDL model, it is important to test the order of integration of the variables. Although it is not important that the order of integration is same for all the variables, it is important to perform the unit root test, nevertheless, just to verify that the variables are not integrated of the second order i.e. I(2). This is important because the ARDL cointegration test cannot be applied if the variables are stationary at second difference I(2). Ng-Perron test has been employed to perform the unit root test. The results indicate that EC and FD are stationary at level while GDP and PHEG are stationary at first difference (Table 1)

Table 1: Unit Root Test

	Ng-Perron			
Variables	MZ_α	MZ_t	MSB	MP_T
EC	-30.5122*	-3.6888	0.1209	1.4542
FD	-8.8898**	-1.7081	0.1921	4.1554
GDP	7.2628	10.9942	1.5137	346.423
PHEG	1.7880	1.0904	0.6098	34.1363
ΔGDP	-17.7519**	-2.8536	0.1607	1.8309
ΔPHEG	-16.0907**	-2.7518	0.2330	3.1700

Note: * Indicates significance at 1%;** Indicates significance at 5%

After getting assured about the order of integration of the variables, we move towards determining the cointegrating relationship among the variables. However before this, there is a need to determine the optimal lag length. Lag 1 is found to be the optimal lag length for our study (Table 2)

Table 2: Lag Order Selection Criteria

Lag	Log likelihood (Log L)	LR statistic	Final Prediction Error (FPE)	Akaike Information criterion (AIC)	Schwartz Information criterion (SC)	Hannan-Quinn Information criterion (HQ)
0	459.07	NA*	2.78e-14	-28.37	-28.15	-28.30
1	461.22	3.50	2.59e-14*	-28.45*	-28.17*	-28.36*

Note: * indicates the lag order selected by each criterion. Each value of LR statistic is at 5% level

Now we test for cointegration among the variables at Lag 1. This requires us to calculate the value of the F-statistics and compare it with the critical values (Table 3). We find that the null hypothesis of no cointegration are rejected when GDP, PHEG & EC are the forcing variables at lag 1 with F-value at 15.58 exceeding the upper bound value at 1% as well as when GDP, FD & PHEG are the forcing variables at lag 1 with F-value at 9.10. This indicates the presence of cointegration among the variables

Table 3: Cointegration Test

Model	Lag Length	F-statistics	Lower-upper critical bound value at 1%	Lower-upper critical bound value at 5%	Lower-upper critical bound value at 10%
$F_{PHEG}(PHEG_t/GDP_t,FD_t,EC_t)$	1	2.73	4.29-5.61	3.23-4.35	2.72-3.77
$F_{FD}(FD_t/GDP_t,PHEG_t,EC_t)$	1	15.58*	4.29-5.61	3.23-4.35	2.72-3.77
$F_{GDP}(GDP_t/PHEG_t,FD_t,EC_t)$	1	2.18	4.29-5.61	3.23-4.35	2.72-3.77
$F_{EC}(EC_t/GDP_t,FD_t,PHEG_t)$	1	9.10*	4.29-5.61	3.23-4.35	2.72-3.77

Note: * indicates rejection of null at 1%. Critical values have been taken from Pesaran et al. (2001)

Diagnostic tests were conducted to check for serial correlation and heteroskedasticity. To check for serial correlation, Serial Correlation LM test was adopted while for Heteroskedasticity, ARCH & White test were adopted. The specification of the model was tested using Ramsey reset test. The short run stability of the model was tested using CUSUM test (Table 4)

Table 4: Diagnostic & Stability results

Serial correlation	ARCH Test	White Test	Ramsey reset test	CUSUM
0.87(0.42)	0.01 (0.98)	0.18 (0.99)	1.63(0.21)	Stable

The results show the presence of no serial correlation and heteroskedasticity. The value of the Ramsey reset test indicates the presence of a well specified model. In addition to these diagnostic tests, a test for stability namely CUSUM was conducted. If CUSUM plot was found to be within the 5% critical bound, then the null hypothesis of the stability of the parameters cannot be rejected. The test reveals that the CUSUM plot is within the 5% critical bound and hence the parameters do not suffer from any structural instability over the time period of the study (Figure not included due to space constraint).

After identifying that there is cointegration among the variables, we move towards ascertaining the direction of causality by performing a multivariate Granger causality test. This step will help us in identifying the short and the long run causal relationship among the variables. The causality test in our case can be formulated as under:

$$\begin{bmatrix} \Delta PHEG \\ \Delta EC \\ \Delta FD \\ \Delta GDP \end{bmatrix} = \begin{bmatrix} k_1 \\ k_2 \\ k_3 \\ k_4 \end{bmatrix} + \begin{bmatrix} \beta_{11,1} & \beta_{12,1} & \beta_{13,1} & \beta_{14,1} \\ \beta_{21,1} & \beta_{22,1} & \beta_{23,1} & \beta_{24,1} \\ \beta_{31,1} & \beta_{32,1} & \beta_{33,1} & \beta_{34,1} \\ \beta_{41,1} & \beta_{42,1} & \beta_{43,1} & \beta_{44,1} \end{bmatrix} \begin{bmatrix} \Delta PHEG_{t-1} \\ \Delta EC_{t-1} \\ \Delta FD_{t-1} \\ \Delta GDP_{t-1} \end{bmatrix} + \begin{bmatrix} \beta_{11,2} & \beta_{12,2} & \beta_{13,2} & \beta_{14,2} \\ \beta_{21,2} & \beta_{22,2} & \beta_{23,2} & \beta_{24,2} \\ \beta_{31,2} & \beta_{32,2} & \beta_{33,2} & \beta_{34,2} \\ \beta_{41,2} & \beta_{42,2} & \beta_{43,2} & \beta_{44,2} \end{bmatrix} \begin{bmatrix} \Delta PHEG_{t-2} \\ \Delta EC_{t-2} \\ \Delta FD_{t-2} \\ \Delta GDP_{t-2} \end{bmatrix} +$$

$$\text{--------} + \begin{bmatrix} \beta_{11,p} & \beta_{12,p} & \beta_{13,p} & \beta_{14,p} \\ \beta_{21,p} & \beta_{22,p} & \beta_{23,p} & \beta_{24,p} \\ \beta_{31,p} & \beta_{32,p} & \beta_{33,p} & \beta_{34,p} \\ \beta_{41,p} & \beta_{42,p} & \beta_{43,p} & \beta_{44,p} \end{bmatrix} \begin{bmatrix} \Delta PHEG_{t-p} \\ \Delta EC_{t-p} \\ \Delta FD_{t-p} \\ \Delta GDP_{t-p} \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \end{bmatrix} [ECT_{t-1}] + \begin{bmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \end{bmatrix} + \begin{bmatrix} \zeta_1 \\ \zeta_2 \\ \zeta_3 \\ \zeta_4 \end{bmatrix}$$

Where Δ is the difference operator, ECT is the Error Correction Term, C_i (i=1....4) are constants & ζ_i (i=1...4) are serially uncorrected error terms. This test will help in determining the short and long run causality. Long run causality is depicted by a significant error correction term with lag while short run causality is determined by Wald's test. The results of the test are depicted in Table 5 below:

Table 5: Results of Granger Causality Test

Dependent variable	Direction of Causality				
	Short Run				Long Run
	ΔEC	ΔFD	ΔPHEG	ΔGDP	ECT_{t-1}
ΔPHEG	-1.214 (0.2235)	0.9200 (0.3644)	_____	1.7837*** (0.0840)	-0.9648* (0.0018)

Note: * denotes significance at 1% & *** denotes significance at 10%

The results clearly highlight the fact that there is long run causal relationship between energy consumption and public health expenditure, between fiscal deficit and public health expenditure and between gross domestic product and public health expenditure. However in the short run, the only causal relationship that was found to be significant was between GDP and public health expenditure.

5. Conclusion & Policy Implications

The paper examines the relationship between energy consumption, fiscal deficit, GDP and public health expenditure. The study uses the ARDL approach along with Granger Causality test to investigate the long run and short run relationship among the variables. The results show the presence of long run relationship of the three independent variables with public health expenditure in the long run. However in the short run, only GDP was found to be related to public health expenditure. Although the results do not find an evidence of energy consumption and fiscal deficit having any short run causal association with health expenditure, they have an indirect role even in the short run. Economic growth requires energy which can be observed from the positive relation between two in the short run. Since in a country like India where majority of the energy is imported and also subsidised, it has an adverse impact on the fiscal deficit situation which leads the government having to rein its overall expenditure thereby impacting the government expenditure on health.

The long run causal relationship from energy consumption, fiscal deficit and gross domestic product to government health expenditure clearly supports the idea espoused before. Ideally what should happen is that higher economic growth should lead to higher government health expenditure but due to the moderating role of imported energy, the beneficial effects in terms of proportional increment in spending on health in relation to increase in GDP are not observed. Therefore, it is imperative for policy makers to either try to reduce the energy consumption in the country which would be difficult to do considering the fact that we are still a developing country and have aspirations to become a developed one which will require industrialisation thus leading to even more of energy use or an attempt be made to explore more sources of energy in our country itself. However, we have to mindful of the fact there is a limit to the non-renewable sources that the country and the world have and there are associated environmental costs associated with their exploration. Hence the need arises in the country to vigourously pursue the agenda of developing the renewable sources of energy not only as a means to protect the environment but also to have a favourable impact on government health spending. The policy makers will also have to take an affirmative action in regard to deregulation of oil prices and in areas where they cannot be completely deregulated, the subsidies will have to be better targeted. An attempt has begun in this direction with deregulation of diesel prices and plans to directly transfer subsidies to beneficiaries account. These steps will save crucial financial resources of the country which can then be used towards improving the public health infrastructure in the country.

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Biography

The author is a Doctoral Scholar in the area of Economics at the Indian Institute of Management, Indore. His research interest is in the area of Development Economics especially in the domain of Health.