DYNAMIC EFFECTS OF HEALTH EXPENDITURE SHOCKS ON HIV PREVALENCE IN SUB-SAHARAN AFRICA

BERNHARD O. ISHIORO
Delta State University, Abraka, Nigeria
ben_ishioro@yahoo.co.uk

Abstract

This study has investigated the dynamic effects of health expenditure shocks on the mitigation of HIV prevalence in sub-Sahara African region using aggregate time series data. HIV prevalence rate for adults and four components of health expenditure: health expenditure per capita, private health expenditure, public health expenditure and total health expenditure were used as the proxies in our models. Apart from the unit root and the cointegration tests, we also applied the Vector Autoregressive model in the analysis of the impacts of the patterns of persistent common variations of health expenditure shocks transmitted to HIV prevalence and from HIV prevalence to health expenditure. The study established that the response of HIV Prevalence to health expenditure shocks was equi-proportional and prompt. Furthermore, our results indicated that a positive HIV prevalence shock would lead to a consistently diverging negative responses from the health expenditure variables; suggesting that a rise in the tempo of HIV prevalence would exert a persistently negative inter-period effects on health expenditures. The study recommended that health expenditures in the sub-Saharan region should be well-managed in order to mitigate the spread of HIV prevalence effectively and sustainably.

Keywords: Health Expenditure shocks, HIV prevalence, Health Expenditure, Sub-Saharan Africa

JEL Classification: I10, I11, I15

1. INTRODUCTION

Globally, health expenditure (hereafter HE), otherwise known as health spending, is one of the major avenues of expenditure for both governments (domestic and foreign), donor agencies, multi-lateral organizations, and private individuals during the era of HIV prevalence (hereafter HIVP). Other components of HE treated as aggregate expenditure include public, household out-of-pocket private health expenditure, non-household private health expenditure, and total health expenditure (TOTHEXP) (Ishioro,2018) often treated as a proxy for aggregate health expenditure, has the capacity to transmit exogenous shocks to health outcomes (such as HIV prevalence), other macroeconomic variables and its own components.

Furthermore, each of these components of HE (denoted as public, household out-of-pocket private health expenditure, and non-household private health expenditure) has the tendency to transmit dynamic exogenous shocks to other components of HE, including TOTHEXP, macroeconomic indicators, and health outcomes, the most prominent of which is HIVP.

There are a lot of studies on health and economic growth (Barro and Lee, 2000; Ravallion, 2003; Mayer-Foulkes, 2004) , and on the relationship between HIVP and economic growth (Nicholls et al., 2000; Cornia and Zagonari, 2007; Bloom and Mahal, 1997; Cuddington, 1993a, 1993b; Arndt and Lewis, 2000; Bell and Gersbach, 2006). Many studies have been conducted on the impact of HIVP on the health sector, agricultural sector, manufacturing sector, and education sector (Over, 2004). Almost all the aspects of the impact of HIVP are well-documented except for the relationship between HIVP and HE shocks. This aspect is not enough researched for Africa and the sub-regions of Africa as there has been an increasingly decreasing effort and progress made in understanding the shocks of the HE foundations of the HIV epidemic. These shocks represent monumental and seemingly insurmountable variations that pose serious challenges to poor countries with bloated annual recurrent expenditures. The literature on this subject matter is still emerging and currently very scarce. Therefore, there is a need for both African-specific and African sub-region-specific studies on the link between HE shocks and HIVP, and *vice versa*.

Furthermore, the unprecedented growth of TOTHEXP, PUBHEXP, and PRIHEXP in the era of the HIV pandemic has become a serious research and policy issue in the past few decades. The expenditure implications of the epidemic shocks are heightening and widening daily. For instance, the global funding of HIVP-induced HE rose dramatically and sharply from US $260 million in 1996 to about US $15.9 billion in 2009 (UNAIDS, 2010), constituting positive exogenous expenditure shocks to the mitigation of the disease.

Most sub-regions in Africa that are currently over-burdened with HIV/AIDS are also heavily indebted poor regions with very weak, frail and ailing economic structures (for instance, east African sub-region). Hence, HIVP has aggravated the economic crises of some of these nations and regions by further enlarging their already-bloated expenditures. This has created serious HIV-orchestrated-expenditure gap. Therefore, most studies described HIV/AIDS as precipitating highly persistent expenditure / fiscal shocks (European Commission, 2016, 2017; Blanchard and Leigh, 2013; Braithwaite *et al*., 2017). Therefore, this current study seeks to answer the following questions: What are the HE implications of the prevalence of HIV/AIDS shocks in sub-Saharan Africa (hereafter SSA)? What are the implications of the HE shocks for the mitigation of prevalence of HIV/AIDS in SSA? What is the nature of the HE shocks? Positive, negative or conservative (zero)? Answers to these questions are important because whenever a new infection is recorded, it generates shocks that have serious consequences for future health expenditure planning and policies in the region in and the globe in general.

The rest of this paper is presented as follows: Section two concentrates on literature review, while section three highlights the thematic framework of the model adapted for the econometric specification of our models. Section four describes the basic methodological issues (data sources and definition, specification of econometric models and estimation techniques).The last two sections (five and six) discuss the results and conclude the paper.

2. LITERATURE REVIEW

Aggregate health care expenditure (henceforth HCEXP) and its components have different macroeconomic consequences for the economy. These consequences are often transmitted through various channels to either the economy or specific macroeconomic fundamentals (Hsiao and Heller, 2007). Besides, aggregate health care spending has fiscal implications. These include long-term fiscal sustainability with severe consequences for public debt and short-term fiscal multipliers (Darvas *et al*., 2018). Also, they have impacts on the labor market (especially labor supply and demand effects) and the performance of the health sector, with implicit implications for the number of days spent at home due to morbidity (Suhrcke *et al.*, 2005). Furthermore, HCEXP, according to Darvas *et al*. (2018), has consequences for the prevalent nature of income inequality (Morris *et al.*, 2005), economy-wide and/or sector-specific productivity (Spasova *et al*., 2016), and human capital (health and education human capital) accumulation.

Yeboah *et al*. (2014) in a study of the expenditure pattern of HIV/AIDS-burdened countries (consisting of 49 low and middle income and poor countries, and a total sample of 86 countries) for the period 1990 to 2012 applied the instrumental variables econometric technique with specific adoption of the Two-Stages-Least Squares (2SLS) regression analysis. The study observed that HIV/AIDS reduces the savings and investment potential of affected households by increasing their out-of-pocket (PRIHEXP) expenditure on health care goods and services. The study concluded that for low-income countries who are also HIV prevalence-trapped, the epidemic diverts and subverts public spending from growth-enhancing investments to health care expenditures-proned.

David *et al*., (2014) studied the trends of HIV-induced spending and expenditure in affected countries. The study noted that HIV/AIDS financing whether among high, medium or low HIVP countries was characterized by high donor dependency (a good example of PUBHEXP).The study established that over 80 percent of resources for HIV prevention and treatment were externally-provided among high or low HIVP countries. The study also confirmed that in terms of the private share of health spending; out-of-pocket was substantial and could become a "drain and debacle" on family savings and income. The study deduced from their review that several governments are under pressure to stem-up funding for HIV treatment, prevention and campaign. For instance, in 1999, the government of Zimbabwe set up a three (3) percent levy fund for the National AIDS council (NAC); generated US$2.6 billion between 2000 and 2006 as HE for HIV/AIDS. The Zimbabwean NAC raised US$2.6 million in 2011. Mozambique followed this pattern of HIV-induced HE. The study noted that most HIV-burdened countries have applied for debt forgiveness to enable them cope with their HIV-expenditure-expanded budgets.

Over (2004) opined that HIV incidence and prevalence have several severe implications for either the expansion or contraction of the HE of the economy (TOTHEXP, private or public health expenditure). In poor countries with weak or non-existent health sectors or institutions, where standard health facilities were lacking before the epidemic, the health expenditure was substantial. For instance, Uganda's HCEXP rose to about US $1.2 million due to the severity of the epidemic. The study also noted that, from the microeconomic point of view, HIVP has increased the demand for health care services without a proportionate increase in supply. The study observed that prices and costs of health care would go up, thereby increasing or expanding PRIHEXP. Since HIV-infected households are usually overburdened with HCEXP, part of the burden would be shifted to either the government, the public, or donor agencies. This is expected to increase PUBHEXP in both short and long-run periods.

WHO (2014) has noted that since HIVP is usually associated with a lot of opportunistic diseases (such as tuberculosis, pneumonia, malaria fever, meningitis, cholera, etc.), all categories of expenditure are expected to increase and, in most cases, to be exceptionally high. The WHO (2014) statistics suggest that health expenditure is increasing at an increasing rate across the regions of SSA, especially for regions that are HIV-trapped or burdened.

3. MATERIALS AND METHODS

3.1. DATA: SOURCES AND DESCRIPTION

Although they are time series data, the data used for this study and the estimation of our models are aggregate sub-Saharan African-wide (aggregate region) in nature and were sourced from the World Bank's World Development Indicators (WDI) for various years. The nomenclature of the series used for this study is presented in table 1 and includes:

Table 1: *Definition and Description of Series Used in this Study*

S/N	Series	Symbol used	Definition / Source of Data
1	Adult HIV prevalence rate	HIVP	Obtained from WDI, 2021
2	Health expenditure per capita	HEXPPCA	Obtained from WDI, 2021
3	Private health expenditure	PRIHEXP	Obtained from WDI, 2021
4	Public health expenditure	PUBHEXP	Obtained from WDI, 2021
5	Total health expenditure	TOTHEXP	Obtained from WDI, 2021

Source: Author's Compilation (2021)

3.2. ESTIMATION TECHNIQUE

3.2.1. UNIT ROOT TEST

This study applied three unit root testing techniques: Augmented Dickey Fuller (ADF), Phillips-Perron unit root, and KPSS unit root tests (Ishioro, 2015a, 2015b, 2016, 2017, 2018a, 2018b). The stationarity test of time series data has been advocated because of the properties of this type of data that can impinge on the consistency and appropriateness of the results obtained from their econometric application.

More so, the unit root tests are designed to provide information about integration of the series (whether I(0) or I(1)). This is important because the knowledge of the order of integration of the series has several implications for the application of the cointegration and Granger causality tests (Ishioro 2020a, 2020b, 2019).

3.2.2. COINTEGRATION TESTS

The Johansen cointegration test has been applied in the determination of the long-run relationship between or among the series (HEs and HIVP) adopted in this study. The confirmation of the existence of a long-run relationship between or among the selected indicators has extensive policy implications (Ishioro 2020a, 2020b, 2019). Principally, it means that a conservative reduction of one of the indicators will hamper the performance of the others.

3.2.3. VECTOR AUTOREGRESSIVE ESTIMATION TECHNIQUE

In the macroeconomic and econometric literature, vector autoregressive models have been widely applied in the evaluation of different thematic research issues since the path-breaking study by Sims (1980) and have recently been adopted by Wichitaksorn (2020); Krkošková (2020); Aparicio and Bertolotto (2020); Farzanagan *et al*. (2020); Pasara *et al.* (2020); Nguyen, Harvie and Suardi (2020); Ishioro (2020a, 2020b, 2019); Nuru (2019); Pandey and Jessica (2019); Vo, Ho and Vo (2019); Gereziher and Nuru (2019); Dizaji (2019); Yong (2019), and Rossi and Wang (2019) in different areas of analysis.

Following Sims (1980), and Stock and Watson (2001), the Vector Autoregressive model adopted in this study is of the order *k* (that is, VAR (*k*)). It is specified as:

$$\lambda(L)Y_t = \phi + R_t + \Theta + e_t \tag{1a}$$

Or more explicitly as:

$$Y_t = \phi + R_t + \Theta + \xi_1 Y_{t-1} + \xi_2 Y_{t-2} + \ldots + \xi_k Y_{t-k} + e_t \tag{1b}$$

In equation (1a) and (1b), Y_t is the vector for the set of the n[th] series and is an $n \times 1$ column vector of the VAR, and can be represented as $Y_t = (Y_1, Y_2, \ldots, Y_n)$; ϕ

represents the constant term and is the vector for the VAR's constant term; R_t is the vector for the regressors related to the deterministic terms $(e_t(s))$ and is a column vector with deterministic series:

$$\lambda(L) = 1 - \sum_{j=1}^{n} \xi_j L^j \qquad (1c)$$

The VAR models (1a) and (1b) are used as benchmarks for the estimation of our HIVP-HE models.

Our VAR for the HIVP and various definitions of HE is a 5-equation, 5-variable linear model wherein each of the variables is explained by its own past values, including current and past values of the other 4 variables.

$$(V_0)(y_t) = (V_{1t})(Ly_{t-i}) + (\varepsilon_t)$$

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix} \begin{pmatrix} HIVP \\ PRIHEXP \\ PUBHEXP \\ HEXPPCA \\ TOTHEXP \end{pmatrix} = V(L) \begin{pmatrix} HIVP \\ PRIHEXP \\ PUBHEXP \\ HEXPPCA \\ TOTHEXP \end{pmatrix} + \begin{pmatrix} \varepsilon_{HIVP} \\ \varepsilon_{PRIHEXP} \\ \varepsilon_{PUBHEXP} \\ \varepsilon_{HEXPPCA} \\ \varepsilon_{TOTHEXP} \end{pmatrix} \quad (2)$$

equation (2) is specified in variable-specific terms as:

$$HIVP_t = a_{11}HIVP_{t-1} + a_{12}PRIHEXP_{t-1} + a_{13}PUBHEXP_{t-1} + a_{14}HEXPPCA_{t-1} + a_{15}TOTHEXP_{t-1} + b_{11}HIVP_{t-2} + b_{12}PRIHEXP_{t-2} + b_{13}PUBHEXP_{t-2} + b_{14}HEXPPCA_{t-2} + b_{15}TOTHEXP_{t-2} + c_1 + e_{1,t} \qquad (2a)$$

Equation (2a) hypothesizes that the current HIVP rate depends on its own past values and the past values of PRIHEXP, PUBHEXP, HEXPPCA, and TOTHEXP.

$$PRIHEXP_t = a_{21}HIVP_{t-1} + a_{22}PRIHEXP_{t-1} + a_{23}PUBHEXP_{t-1} + a_{24}HEXPPCA_{t-1} + a_{25}TOTHEXP_{t-1} + b_{21}HIVP_{t-2} + b_{22}PRIHEXP_{t-2} + b_{23}PUBHEXP_{t-2} + b_{24}HEXPPCA_{t-2} + b_{25}TOTHEXP_{t-2} + c_2 + e_{2,t} \qquad (2b)$$

Equation (2b) posits that current PRIHEXP depends on its own past values and the past values of HIVP, PUBHEXP, HEXPPCA, and TOTHEXP.

$$PUBHEXP_t = a_{31}HIVP_{t-1} + a_{32}PRIHEXP_{t-1} + a_{33}PUBHEXP_{t-1} + a_{34}HEXPPCA_{t-1} + a_{35}TOTHEXP_{t-1} + b_{31}HIVP_{t-2} + b_{32}PRIHEXP_{t-2} + b_{33}PUBHEXP_{t-2} + b_{34}HEXPPCA_{t-2} + b_{35}TOTHEXP_{t-2} + c_3 + e_{3,t} \qquad (2c)$$

Equation (2c) implies that current PUBHEXP depends on its own past values and on the past values of HIVP, PRIHEXP, HEXPPCA, and TOTHEXP.

$$HEXPPCA_t = a_{41}HIVP_{t-1} + a_{42}PRIHEXP_{t-1} + a_{43}PUBHEXP_{t-1} + a_{44}HEXPPCA_{t-1} + a_{45}TOTHEXP_{t-1} + b_{41}HIVP_{t-2} + b_{42}PRIHEXP_{t-2} + b_{43}PUBHEXP_{t-2} + b_{44}HEXPPCA_{t-2} + b_{45}TOTHEXP_{t-2} + c_4 + e_{4,t} \quad (2d)$$

Equation (2d) hypothesizes that current HEXPPCA is a function of its own past values and the past values of HIVP rate, PRIHEXP, PUBHEXP, and TOTHEXP.

$$TOTHEXP_t = a_{51}HIVP_{t-1} + a_{52}PRIHEXP_{t-1} + a_{53}PUBHEXP_{t-1} + a_{54}HEXPPCA_{t-1} + a_{55}TOTHEXP_{t-1} + b_{51}HIVP_{t-2} + b_{52}PRIHEXP_{t-2} + b_{53}PUBHEXP_{t-2} + b_{54}HEXPPCA_{t-2} + b_{55}TOTHEXP_{t-2} + c_5 + e_{5,t} \quad (2e)$$

Equation (2e) posits that current TOTHEXP is a function of its own past values and the past values of HIVP rate, PRIHEXP, PUBHEXP, and HEXPPCA.

In equation (2a-2e), ***a, b, and c*** represent the parameters of the VAR to be estimated. Our VAR equation is a 5-equation, 5-variable linear model wherein each of the variables is explained by its own past values, including current and past values of the other 4 variables.

3.2.4. IMPULSE RESPONSE FUNCTIONS OF THE VAR

The major important characteristic of the impulse response function (henceforth IRF) is that, it traces the effects of one standard deviation (S.D) shock to other innovations on current and future values of the series used in the VAR (Luetkepohl, 2008). With the aid of the dynamic structure of the VAR, shocks generated by the IRF are easily transmitted to all the endogenous variables. From the VAR, in case of innovations; $e_{1,t}, e_{2,t}, e_{3,t}, e_{4,t}, e_{5,t}$;given that the innovations are almost always correlated, a common component which cannot be identified specifically with any of the series is generated thereby making interpretation cumbersome. To solve this problem, we assumed in line with Zha (1998) and Watson (1994) that, all the effect of the common component is generated from or attributed to the variable that comes first in the VAR equation. For instance, the common component of $e_{1,t}, e_{2,t}, e_{3,t}, e_{4,t}, e_{5,t}$ in the first equation (2a) is totally attributed to HIVP's $e_{1,t}$ because it precedes other series in the first VAR equation.

3.3. RESULTS OF UNIT ROOTS AND STATIONARITY TESTS

The results of the three (3) unit root and stationarity tests are presented in table (2).

Table 2: *Results of the Tripartite Unit Root Tests*

Variables	ADF Test Statistics (level)	ADF Test Statistics	PP Test Statistics (At level)	PP Test Statistics (First Diff)	KPSS Test Statistics (level)	KPSS Test Statistics

		(First Diff)				(First Diff)
LNTOTHEXP	-3.297	-3.464***	-3.549	-6.398*	0.034	0.387
LNPRIHEXP	-3.400	-8.882*	-3.808	-9.369*	0.092	0.622
LNPUBHEXP	-0.366	-5.653*	-2.121	-5.643*	0.099	0.161
LNHIVP	-4.391	-3.539**	-5.794	-3.831**	0.158	0.183
LNHEXPPCA	-4.657	-2.723***	-1.778	-2.593*	0.112	0.500

NOTE:* represents (1 percent),**(5 percent) and ***(10 percent)

The results presented for the Augmented Dickey Fuller (ADF) and Phillips-Perron (denoted as PP) unit root tests indicated that all the series (TOTHEXP, PRIHEXP, and PUBHEXP, HEXPPCA, and HIVP) were non-stationary at levels, implying that they possess unit root at levels. These unit root results are in synchrony with myriads of studies that conclude that the surrogates of HE are non-stationary at levels. But the Kwiatkowski-Phillips-Schmidt-Shin (denoted as KPSS) unit root test showed that our series were stationary at levels. However, results of the ADF and PP unit root tests established that the series became stationary after the first difference of each of the series was taken. Therefore, we do not reject the null hypothesis of stationarity at first difference. In contrast to the results of the ADF and PP, the results of the KPSS test indicated non-stationarity at first difference for all our series.

3.4. RESULTS OF COINTEGRATION TEST

The results of the one-on-one Johansen cointegration test are presented in table 3. For HIVP versus HEXPPCA, the results established one cointegrating equation between the variables. This means that there exists a long-run equilibrium relationship between HIVP and HEXPPCA. The policy implication of this is that, any policy reducing HEXPPCA will affect the mitigation of HIVP in the long-run. Also, it means that any effective HIVP mitigation policy or strategy must have long-run consequences for HEXPPCA funding and management.

For HIVP versus PRIHEXP, the results of both trace and maximal Eigen value statistics affirmed the existence of one cointegrating equation between the series. This connotes the existence of a long-run relationship between HIVP and PRIHEXP. The policy implication of this is that, high prevalence and persistence of HIV have long-run private spending implications for HIV-burdened individuals and households as they would be enmeshed in a long-term private expenses on health care; and it also means that, any policy reducing PRIHEXP without a complementary expenditure source will affect the mitigation of HIVP and HIV- affected individuals in the long-run. Also, it means that any effective HIVP mitigation policy or strategy must have long-run funding support from private sources.

For HIVP versus public and TOTHEXP, the results of the trace and maximal Eigen value statistics confirmed the existence of one cointegrating equation between them. This means that there exists a long-run equilibrium relationship between HIVP and PUBHEXP and HIVP and TOTHEXP. The policy implication of this is that any policy reducing both HEs will affect the long-run sustainable mitigation of HIVP.

Table 3: *Results of Johansen Co-integration test*

Unrestricted Cointegration Rank Test (Trace and Maximum Eigen value) [LNHIVP LNHEXPPCA]				
Hypothesized No. of CE(s)	**Eigen-value**	**Trace Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.928	40.812	15.497	0.000
At most 1	0.084	1.320	3.841	0.250
Hypothesized No. of CE(s)	**Eigen-value**	**Max. Eigen Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.928	39.491	14.264	0.000
At most 1	0.084	1.320	3.841	0.250
Unrestricted Cointegration Rank Test (Trace and Maximum Eigen value) [LNHIVP LNPRIHEXP]				
Hypothesized No. of CE(s)	**Eigen-value**	**Trace Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.679	20.449	15.494	0.008
At most 1	0.132	2.267	3.841	0.132
Hypothesized No. of CE(s)	**Eigen-value**	**Max. Eigen Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.679	18.182	14.264	0.011
At most 1	0.132	2.267	3.841	0.132
Unrestricted Cointegration Rank Test (Trace and Maximum Eigen value) [LNHIVP LNPUBHEXP]				
Hypothesized No. of CE(s)	**Eigen-value**	**Trace Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.666	18.668	15.494	0.016
At most 1	7.41E-05	0.001	3.841	0.971
Hypothesized No. of CE(s)	**Eigen-value**	**Max. Eigen Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.666	18.667	14.264	0.009
At most 1	7.41E-05	0.001	3.841	0.971
Unrestricted Cointegration Rank Test (Trace and Maximum Eigen value) [LNHIVP LNTOTHEXP]				
Hypothesized No. of CE(s)	**Eigen-value**	**Trace Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.901	35.395	15.494	0.000
At most 1	0.042	0.658	3.841	0.417
Hypothesized No. of CE(s)	**Eigen-value**	**Max. Eigen Statistics**	**0.05 Critical value**	**Prob. (**)**
None*	0.901	34.737	14.264	0.000
At most 1	0.042	0.658	3.841	0.417

Source: Author's Computation (2021)

3.5. RESULTS OF VARIANCE DECOMPOSITION

From the variance decomposition results of our VAR shown in table 4, 12.6 percent of the variations in HEXPPCA were accounted for by its own shocks after the 10th period, while the major source of shocks experienced by HEXPPCA was from TOTHEXP (which contributed about 69 percent of the cumulative shocks and variations experienced by HEXPPCA during the period under consideration).

Table 4: *Results of Variance Decomposition of Health Expenditure Per Capita*

Period	SE	LHEXPPCA	LHIVP	LPRIHEXP	LTOTHEXP	LPUBHEXP
1	0.0322	100.00	0.000	0.000	0.000	0.000
5	0.159	34.071	23.689	7.087	35.666	7.181
10	0.332	12.576	9.210	7.236	68.783	2.215

Source: *Author's Computation (2021)*

Other shocks were transmitted by HIVP, PRIHEXP, and PUBHEXP, with each accounting for about 9.2, 7.2, and 2.2 percentage points of the variations in HEXPPCA. Fundamentally, our findings revealed some degree of shock substitutability between HEXPPCA and TOTHEXP, as well as some degree of complementarity between HEXPPCA and other variables, including HIVP (tempo of own shocks decreases as the degree of shocks from HIVP, PRIHEXP, and PUBHEXP decreases).

Table 5: *Results of Variance Decomposition of HIV Prevalence*

Period	SE	LHEXPPCA	LHIVP	LPRIHEXP	LTOTHEXP	LPUBHEXP
1	0.082	6.368	93.632	0.000	0.000	0.000
5	0.160	3.867	31.876	3.506	58.330	2.422
10	0.332	4.114	8.358	7.056	79.605	0.867

Source: *Author's Computation (2021)*

Table (5) shows that the greatest shocks and variations experienced by HIVP during the study period were from TOTHEXP (transmitting approximately 80% of the cumulative shocks), while other sources of shocks experienced by HIVP included its own shocks, PRIHEXP, HEXPPCA, and PUBHEXP. These sources accounted for 8.4, 7.1, 4.1, and 0.87 percentage points after the 10th period.

Table 6: *Results of Variance Decomposition of Private Health Expenditure*

Period	SE	LHEXPPCA	LHIVP	LPRIHEXP	LTOTHEXP	LPUBHEXP
1	0.0412	5.954	0.00017	94.046	0.000	0.000
5	0.069	13.158	2.508	51.221	20.664	12.449
10	0.0737	10.560	3.686	41.004	27.656	17.094

Source: *Author's Computation (2021)*

The results of the variance decomposition displayed in table 6 indicated that after the 10th period, the greatest and most monumental shocks experienced by private health expenditure are from its own shocks, accounting for about 41.0 percentage points, while other shocks and variations are from TOTHEXP, PUBHEXP, HEXPPCA, and HIVP, contributing about 27.7, 17.1, 10.6, and 4.0

percent, respectively. As in other cases, the shock from HIVP is the weakest and least profound.

3.6. VARIANCE DECOMPOSITION OF TOTHEXP TO OTHER VARIABLES

Also, from table 7, it was established that the variance decomposition shocks dissipated to TOTHEXP are from their own shocks (36.1 percent) while the other variations and shocks are accounted for and contributed by PRIHEXP (14.0 percent), HEXPPCA (about 11.0 percent) and HIVP, accounting for 3.0 percent of the shocks.

Table 7: *Results of Variance Decomposition of Total Health Expenditure*

Period	SE	LHEXPPCA	LHIVP	LPRIHEXP	LTOTHEXP	LPUBHEXP
1	0.043	10.086	0.0068	0.000	10.922	78.986
5	0.064	14.312	1.230	10.026	36.663	37.769
10	0.069	12.841	2.840	34.703	36.068	13.548

Source: *Author's Computation (2021)*

As aptly observed in other cases, the shocks from HEXPPCA are unstable and "sinusoidal" by nature, indicating non-sustainability of the shocks.

3.7. VARIANCE DECOMPOSITION OF LPUBHEXP TO OTHER VARIABLES

The variance decomposition for the period studied by our VAR, as shown in table 8, indicated that after the 10th period, 58.2 percent of the shocks and variations experienced by PUBHEXP were mainly accounted for and explained by shocks from TOTHEXP, while its own shocks accounted for the 2nd weakest of 4.5 percentage points. However, other shocks experienced by PUBHEXP are from PRIHEXP, HEXPPCA, and HIVP, accounting for 19.0, 15.0, and 4.0 percentage points.

Table 8: *Results of Variance Decomposition of Public Health Expenditure*

Period	SE	LHEXPPCA	LHIVP	LPRIHEXP	LTOTHEXP	LPUBHEXP
1	0.054	12.872	0.109	21.795	65.135	0.0881
5	0.074	14.922	2.694	20.085	58.274	4.044
10	0.085	14.901	3.549	18.871	58.167	4.512

Source: *Author's Computation (2021)*

3.8. RESULTS OF IMPULSE RESPONSE

The results of the impulse responses of our VAR models are reported in table 9- table 13.

Table 9: *Results of Impulse Response to Cholesky One SD Innovation of LHIVP*

Period	LHIVP	LHEXPPCA	LPUBHEXP	LTOTHEXP	LPRIHEXP
1	0.0036	0.000	0.000	0.000	0.000
5	0.0071	0.0065	0.017	-0.0043	-0.0029
10	0.005	0.0076	0.033	-0.0072	-0.0038

Source: *Author's Computation (2021)*

The results of the impulse response of one standard deviation shock of HIVP to the innovations of own current value and components of HE. The responses of all the variables (except TOTHEXP and private health expenditure) were positive. The negative response of TOTHEXP implies that as more persons are infected and affected by the disease and become morbid , the proportion of the population who are HIV positive grows each year as a result negative health expenditure-pressures are exerted on TOTHEXP making the TOTHEXP accumulated during the previous period inadequate for the current population. This means that saving and investment enhance current performance of TOTHEXP while the expansion of the proportion of the population who are HIV-positive reduces TOTHEXP. Therefore, the response is negative.

Furthermore, as the HIV epidemic heightens during the 5th and 10th period, the proportion of HIV positive individuals and households/affected firms increases making previously accumulated or investment in PRIHEXP inadequate .Hence, the negative response to the HIVP shock.

Table 10: *Results of Impulse Response to Cholesky One SD Innovation of LHEXPPCA*

Period	LHIVP	LHEXPPCA	LPUBHEXP	LTOTHEXP	LPRIHEXP
1	-0.021	0.080	0.000	0.000	0.000
5	-0.038	-0.0191	-0.0174	0.014	0.027
10	-0.0069	-0.0312	-0.0137	0.025	0.0088

Source: *Author's Computation (2021)*

The results of the impulse response of one standard deviation shocks from HEXPPCA were transmitted to other variables in the VAR model. The response of HIVP to the shocks was consistently negative after periods 1, 5, and 10. This means that shocks transmitted from HEXPPCA have reducing effects on HIVP. The negative responses of own value and public health expenditure to one standard deviation shock from HEXPPCA represent a "shock *substitutionary behavior"*. The major connotation of this is that both HEXPPCA and PUBHEXP are part of public expenditure and can effectively substitute for each other. The positive responses of TOTHEXP and PRIHEXP imply "complementarity". This suggests that HEXPPCA needs the complementarity of both TOTHEXP and PRIHEXP to effectively mitigate HIVP.

Table 11: *Results of Impulse Response to Cholesky One SD Innovation of LPUBHEXP*

Period	LHIVP	LHEXPPCA	LPUBHEXP	LTOTHEXP	LPRIHEXP
1	-0.024	0.0147	0.0385	0.000	0.000
5	-0.0055	-4.50E-05	0.0107	-0.0050	0.0015
10	0.0036	-0.0026	-0.0092	-0.002	-0.0039

Source: *Author's Computation (2021)*

The explanation of the results in table 10 suffices for table 11.

Table 12: *Results of Impulse Response to Cholesky One SD Innovation of LTOTHEXP*

Period	LHIVP	LHEXPPCA	LPUBHEXP	LTOTHEXP	LPRIHEXP
1	-0.003	0.0133	0.031	0.026	0.000
5	-0.00038	0.0078	0.0089	-0.0003	0.0070

10	0.002	0.00023	0.0058	-0.005	-0.0070

Source: *Author's Computation (2021)*

The results of the impulse response of one standard deviation cumulative shocks from TOTHEXP transmitted to HIVP, HEXPPCA, PUBHEXP, PRIHEXP and own value in the VAR model presented in table 12. The response of HIVP to the shocks was consistently negative after the 1st and 5th periods but became positive during the 10th period. This means that shocks transmitted from TOTHEXP had reducing impacts on HIVP during only the 1st and 5th periods. However, the behavior of HIVP during the 10th period connotes non-sustainability of the ' *reducing impacts* ' generated by TOTHEXP during the previous periods. The consistent positive response of HEXPPCA and PUBHEXP , and the mixed responses of own value and PRIHEXP suggest that TOTHEXP needs the complementarity of HEXPPCA and PUBHEXP for optimal performance during the era of HIVP. Health expenditure per capita and public health expenditure displayed irreversible complementarity while own value and PRIHEXP show reversible or non-sustainable complementarity.

Table 13: *Results of Impulse Response to Cholesky One SD Innovation of LPRIHEXP*

Period	LHIVP	LHEXPPCA	LPUBHEXP	LTOTHEXP	LPRIHEXP
1	-00034	0.0127	0.026	0.0452	0.0009
5	0.0036	0.0137	0.0075	0.0036	0.0115
10	0.0010	0.0023	0.00163	--0.0075	-0.0095

Source: *Author's Computation (2021)*

The results of the impulse response function of one standard deviation shocks transmitted from PRIHEXP to HIVP, HEXPPCA, PUBHEXP, TOTHEXP, and own value in the VAR model are as shown in table 13. First, the response of HIVP to the shocks was only negative after the 1st period but became positive during the 5th and 10th periods. This seems to suggest that PRIHEXP can only be potent enough to mitigate HIVP during the initial stage (as shown in period 1). However, beyond that period, only PRIHEXP cannot be relied upon for effective curtailing of the epidemic. It can only play the role of a complimentary HE. For effective complementarity, private health expenditure can be conveniently complemented with health expenditure per capita and public health expenditure.

3.9. RESULTS OF IMPULSE RESPONSE FUNCTION FROM HIVP TO OWN AND OTHER VARIABLES

The first row from the top of the results shows the impulse response of HIVP to its own value, HIVP and other variables (such as HEXPPCA, PRIHEXP, PUBHEXP, and TOTHEXP) shocks.

The responses of HEs to HIVP shocks were damp and sticky around zero (non-responsive) during the 1st to 6th periods but exhibited mirrored divergent, precipitous, and non-astringent behavior from the 7th to 10th periods. It means that during the 1st to 6th periods, the responses of HEs to HIVP shocks were significantly zero and damp, reflecting and validating the fact that HIVP shocks were asymptomatic during the initial periods.

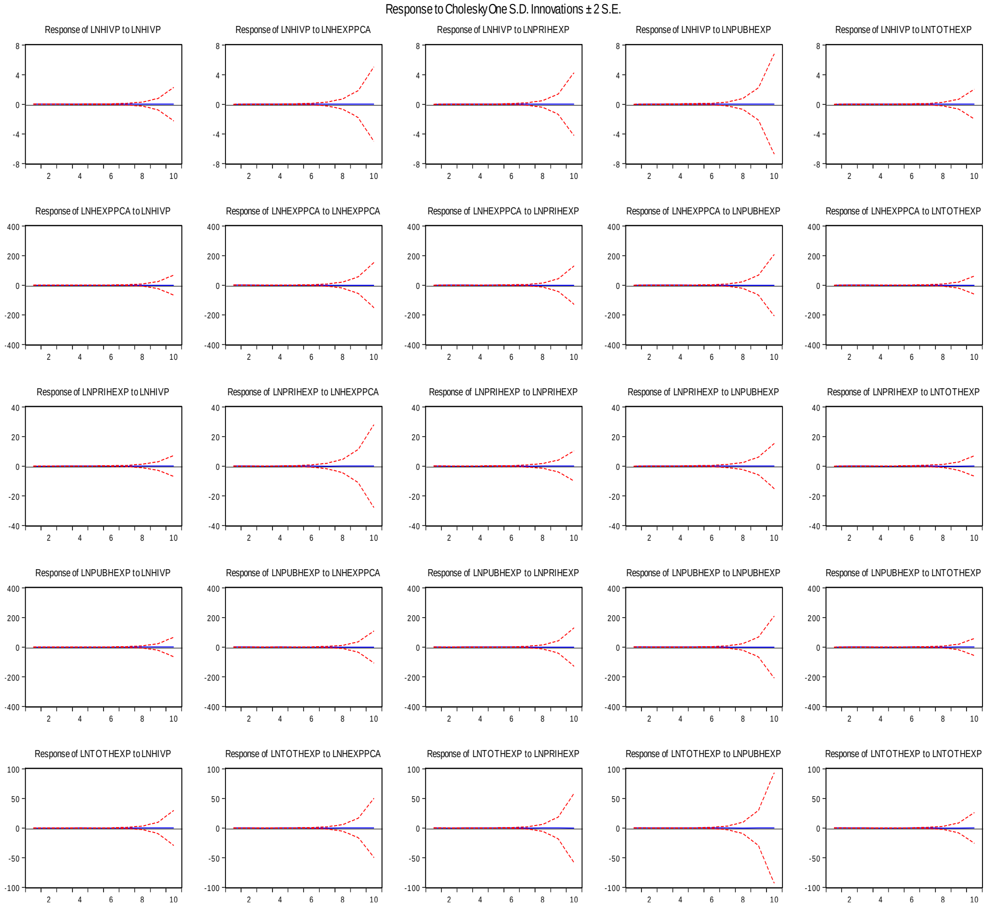

***Figure 1:** Impulse Response Function from HIVP to Own and Other Variables*

However, as HIVP heightens during the 7th to 10th periods, the responses of HEXPPCA, PRIHEXP, and PUBHEXP become negative. This implies that HIVP shocks exerted a pronouncedly significant impact on HEs in SSA but only after the 6th period.

The IRF portrayed above traces the effects of a one-percent shock of HIVP to own HIVP and others such as HEXPCCA, PRIHEXP, PUBHEXP, and TOTHEXP. HIVP did not respond to HEXPPCA, PRIHEXP, PUBHEXP, and TOTHEXP shocks until after the 6th period and markedly responded after the eighth period. But most of all, the response of the HIVP to own and TOTHEXP shocks appears to be muted before the tenth period. HIVP responded more to the shocks from HEXPPCA and PUBHEXP and less to PRIHEXP. This implies that changes in the level of HEXPPCA and PUBHEXP are likely expected to have more profound impacts on the mitigation of HIVP than those of PRIHEXP and TOTHEXP. A major finding from this observation is that HIVP responded differentially to shocks from different components of health expenditure. Surprisingly, the results obtained by this study suggest that as shocks from HIVP increase at an increasing rate, all the shocks from HEs decrease significantly, with PUBHEXP, HEXPPCA, PRIHEXP, and TOTHEXP declining less significantly in that order.

From the first column from the left, the results of the responses of HEXPPCA, PRIHEXP, PUBHEXP, and TOTHEXP to shocks of HIVP show that HIVP-induced shocks were not significant in explaining the changes in HEXPPCA, PRIHEXP, PUBHEXP, and TOTHEXP before the 8th period. This confirms the asymptomatic period of HIVP in sub-Saharan Africa. Considering inter-HEs' responses to shocks as displayed in columns 2, 3, 4 and 5 from the left, the results suggest that responses of the other HEs to shocks from TOTHEXP appear to be more muted and less responsive while it is different for others.

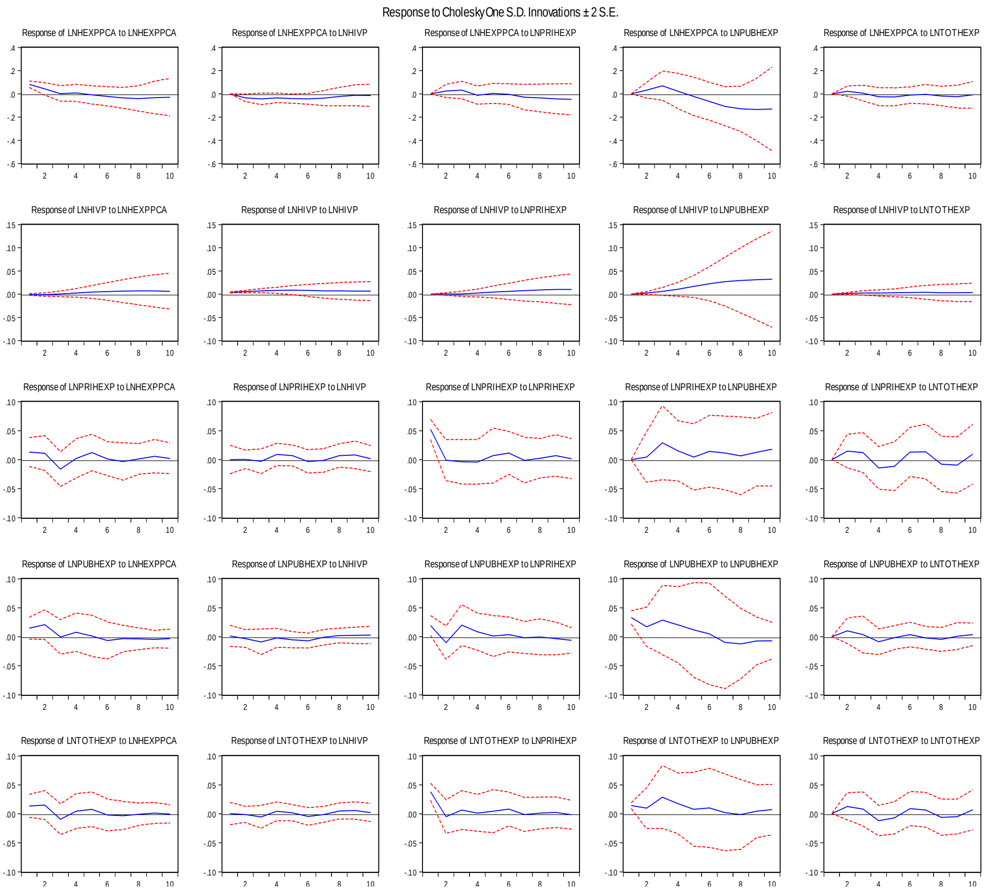

***Figure 2**: Impulse Response Function from Health Expenditures to Own Variables and HIVP*

The impulse response to Cholesky's one S.D. innovation is different in Figure 2 due to an econometric adjustment made in the structure of the analysis. The results show that the health expenditure per capita responds to one percent (1%)

shocks to HIVP, PRIHEXP, PUBHEXP, and TOTHEXP are similar in terms of direction but are different in terms of the speed of divergence and magnitude of response; that is, their responses are similar but display some elements of uniqueness. Row 2 of Figure 2 shows that the response of HIVP to health shocks is relatively insignificant in the case of all HE components except PUBHEXP. PUBHEXP has been defined as consisting of capital and recurrent expenditures of local and external governments; external borrowings; and grants from donor agencies (Ishioro, 2018a). It means that the shocks generated by local and external governments' capital and recurrent budget expenditures, as well as external funding (either borrowed or granted), are more significant and monumental than shocks from other expenditure sources.

But in all cases, as HEXPPCA increased, it exhibited stifling effects on both HIVP and other HEs. However, this is more pronounced with PUBHEXP as its negative divergence after the 2nd period increased increasingly until after the 10th period. The responses of the HIVP and other series representing HE to PUBHEXP shocks are shown in column 4 from the left (or column 2 from the right) of figure 2. The responses of HEXPPCA and HIVP to one percent standard deviation shocks from PUBHEXP depicted a diverging (but fluctuating diverging in the case of HEXPPCA) response, while in the case of PRIHEXP, the response to the PUBHEXP was a constantly fluctuating response across different periods, portending sustained dynamic reception of the shocks. However, the responses of PUBHEXP to own 1 percent shocks and TOTHEXP to PUBHEXP shocks are mixed. It shows a reducing effect, with both series sharply converging towards the 10th period. In both cases, it took almost 10 periods before PUBHEXP and HEXPPCA started showing tendencies to return to the initial steady state.

The following can be observed from the results analyzed above:

First, a constantly positive HE shock will lead to a constantly negative HIVP change, but only in the case of PRIHEXP, PUBHEXP, and TOTHEXP. This implies that HIVP's response to expenditure shocks was equi-proportional and prompt.

Second, using HIVP as the shock variable (as in the case of the 2nd row from the top), a positive HIVP shock would lead to a consistently diverging negative response from the HE variables. This means that a rise in the tempo of HIVP would exert a persistently negative inter-period effect on HE.

4. CONCLUSION AND RECOMMENDATIONS

This study has investigated the dynamic effects of HE shocks on HIVP using aggregate time series data for the region, and in line with Darvas *et al*. (2018), we observed that the prevalence of HIV as a health outcome does not respond to just more health spending. Rather, the shocks from HE show that there seems to be a fiscal turning point at which more health spending won't lead to improvement in the mitigation of HIVP, i.e., a point at which a positive HIVP shock would lead to a consistently diverging negative response from the HE variables. This means that a rise in the tempo of HIVP would exert a persistently negative inter-period effect on HE.

Furthermore, we conclude that if the impacts and consequences of HE shocks (even when negligible) are transmitted to health outcomes such as HIVP, it might result in a mis-allocation of scarce public and private health resources, thereby wasting funds.

Furthermore, our results seem to indicate that, considering the nature of HE shocks generated by the various definitions of HE used in this study, even if the current level of health development assistance is maintained, the expenditure gap created by such shocks would still pose an enormous fiscal challenge in SSA. The study recommends that for the purpose of effective complementarity expenditure, each component of HE should be complemented with other HEs.

REFERENCES

Aparicio, D., & M. I. Bertolotto. (2020). Forecasting Inflation with Online Prices. *International Journal of Forecasting*, 36(2), 232-247.

Arah, O. A., G. P. Westert, J. Hurst & N. S. Klazinga (2006) A Conceptual Framework for the OECD Health Care Quality Indicators Project, *International Journal for Quality in Health Care*, 18 (suppl. 1), 5-13

Arcos-Vargas, A., F. Nuñez, & R. Román-Collado. (2020) Short-term Effects of PV Integration on Global Welfare and CO2 Emissions. An Application to the Iberian Electricity Market. *Energy 200*, 117504.doi.10.1016/j.energy 2020.117504

Arndt, C. & Lewis, J.D. (2000) The Macro Implications of HIV/AIDS in South Africa: A Preliminary Assessment. *South African Journal of Economics*, 68(5), 380-392.

Barro, R.J. & Lee, J.(2000) *International Data on Educational Attainment: Updates and Implications*. Oxford Papers.

Bell, C., Devarajan, S. & Gersbach, H.(2006) The Long-Run Economic Costs of AIDS: A Model with an Application to South Africa . *The World Bank Review*, 20(1), 55-89

Blanchard O. J. & D. Leigh (2013) Growth Forecast Errors and Fiscal Multipliers, *Working Paper 13/1, International Monetary Fund*

Bloom, D.E. & Mahal, A.S. (1997) Does the AIDS Epidemic Threaten Economic Growth ? *Journal of Econometrics*, 77(1), 105-124

Braithwaite, J., P. Hibbert, B. Blakely, J. Plumb, N. Hannaford, J. C. Long & D. Marks (2017) Health System Frameworks and Performance Indicators in Eight Countries: A Comparative International Analysis, *SAGE Open Medicine,* 5, 1-10

Brousselle, A., T. Benmarhnia & L. Benhadj (2016) What Are the Benefits and Risks of Using Return on Investment to Defend Public Health Programs? *Preventive Medicine Reports*, 3, 135-138

Carinci, F., K. Van Gool, J. Mainz, J. Veillard, E. C. Pichora, J. M. Januel, I. Arispe, S. M. Kim & N. Klazinga (2015) Towards Actionable International Comparisons of Health System Performance: Expert Revision of the OECD Framework and Quality Indicators, *International Journal for Quality in Health Care*, 27(2), 137-146

Cornia, G. & Zagonari, F. (2007) The HIV and AIDS Impact on the Rural and Urban Economy, 185–205. In: (Cornia, G., Ed) AIDS, *Public Policy and Child Well-being* (2nd Ed). UNICEF Innocenti Research Centre, Florence.

Cuddington, J.T. (1993a) Modelling the Macroeconomic Effects of AIDS with an Application to Tanzania. *The World Bank Economic Review*, 7(2), 173-189.

Cuddington, J.T. (1993b) Further Results on the Macroeconomic Effects of AIDS: The Dualistic Labour -Surplus Economy. *The World Bank Economic Review*, 7(3), 403-417 (September).

Darvas, Z., N. Moes, Y. Myachen Kova & D. Pichler (2018) The Macroeconomic Implications of Health Care. *Policy Contribution*, Issue No.1, August

David, W., M. Emiko, L. Jack & J. Taafe (2014).*Options for Sustainable and Innovative HIV Financing*, The World Bank, World Bank Group Publication

De la Maisonneuve, C. & J. Oliveira Martins (2013) A projection method for public health and long-term care expenditures. *OECD Economics Department Working Papers*, No. 1048, Organization for Economic Co-operation and Development

Dizaji. S. F., (2019). Trade Openness, Political Institutions, and Military Spending (Evidence from lifting Iran's Sanctions). *Empirical Economics*, 57(6), 2013-2041.

Einav, L. & A., Finkelstein (2011) Selection in Insurance Markets: Theory and Empirics in Pictures, *Journal of Economic Perspectives*, 25(1), 115-138

European Commission (2016) . *Fiscal Sustainability Report 2015*, Institutional Paper 018

European Commission (2017) . *State of Health in the EU: Companion Report*

Farzanegan, M. R., M. Hassan & A. M. Badreldin. (2020). Economic Liberalization in Egypt: A way to Reduce the Shadow Economy? *Journal of Policy Modeling*, 42(2), 307-327.

Fetter, R. B. (1991) Diagnosis Related Groups: Understanding Hospital Performance, *Interfaces*, 21(1), 6-26

Gerdtham, U. G., M. Löthgren, M. Tambour & C. Rehnberg (1999) Internal Markets and Health Care Efficiency: A Multiple-output Stochastic Frontier Analysis, *Health Economics*, 8(2), 151-164

Gereziher, H. Y. & N. Y. Nuru. (2019). The Effect of Government Spending Innovations on the Ethiopian Economy. *African Journal of Economic and Management Studies,* 11(1), 109-121.

Hollingsworth, B. & A. Street (2006). The Market for Efficiency Analysis of Health Care Organizations, *Health Economics*, 15(10), 1055-1059

Hsiao, W. C. & P. S. Heller (2007). What Macroeconomists Should Know about Health Care Policy, *Working Paper WP/07/13*, International Monetary Fund

Ishioro, B. O.(2020a) Crude Oil and Economic Growth in Nigeria: A Simplified Pair-wise Causality Test. *Journal of Academic Research in Economics*. 12(2), 224-246

Ishioro, B. O.(2020b) Financial Market Inclusion, Shadow Economy and Economic Growth Paradigm: A Less Developed Country Perspective. *Scientific Papers of the University of Pardubice*, *Series D*, Vol. XXVIII: No.1/ 2020, 67-78

Ishioro, B.O. (2019) Energy Consumption and Economic Growth in Nigeria: An Augmented Neoclassical Growth Model Perspective. *Journal of Environmental Management and Tourism,* Vol. X, Issues 7 (39), 1637-1657, Winter

Ishioro, B.O.(2018a) Energy Consumption and Performance of Sectoral Outputs: Evidence from an Energy-Impoverished Economy, *Journal of Environmental Management and Tourism*, Vol. IX, Winter, 7(31), 1539-1558

Ishioro, B.O.(2018b).Testing for Hsiao Causality among Health Expenditure, HIV prevalence and Economic Growth in Sub-Saharan Africa, University of Maiduguri Sahel Analyst: *Journal of Management Sciences,* 16 (5), 130-147.

Ishioro, B.O.(2017) Banking Sector Reforms and Economic Growth: Recent Evidence from a Reform-Bound Economy. *Binus Business Review*, 8(1), 46-60

Ishioro, B.O.(2016) HIV/AIDS and Macroeconomic Performance :Empirical Evidence From Kenya. *Scientific Papers of the University of Pardubice, Series D,* Vol. XXIII (36): 102-117

Ishioro, B.O.(2015a) Intertemporal Optimization of the Consumption of Petroleum Stock: Empirical Evidence from Nigeria. *Journal of Academic Research in Economics*, 7(2), 232-255

Ishioro, B.O.(2015b) The Long-Run Relationship Between Foreign Reserves Inflows and Domestic Credit: Evidence from a small open Economy, *Oeconomica*, 11.(2), 18-41

Joumard, I., C. André & C. Nicq (2010) Health Care Systems: Efficiency and Institutions, *OECD Economics Department Working Papers 769*, Organization for Economic Co-operation and Development

Knebelmann, J. & C. Prinz (2016) The Impact of Depression on Employment of Older Workers in Europe. Organization for Economic Co-operation and Development (OECD) *Social, Employment and Migration Working Papers (170)*

Kramer, R. A., A. LaRue & P. J. Gergen (1995), Health and Social Characteristics and Children’s Cognitive Functioning: Results from a National Cohort, *American Journal of Public Health* 85(3), 312-318

Krkošková, R.(2020). Relationship Between The Brent Oil Price And The Us Dollar Exchange Rate. *Prague Economic Papers*, 29(2), 187-206.

Lunt, N., R. Smith, M. Exworthy, S. T. Green, D. Horsfall & R. Mannion (2011) Medical Tourism: Treatments, Markets and Health System Implications: A Scoping Review, *Organization for Economic Co-operation and Development (OECD)*

Luetkepohl, H (2008) *Impulse Response Functions. The New Palgrave Dictionary of Economics*, 2nd Edition.

Maisonneuve, C. & J. Martins (2013) Public Spending on Health and Long Term Care: A New Set of Projections, *Economic Policy Paper No. 6*, Organization for Economic Co-operation and Development

Mayer-Foulkes, D. (2004) The Human Development Trap in Mexico. Cetro de Investigocion y Docencia *Economica (CIDE)-Division of Economics*.

Medeiros, J. & C. Schwierz (2015). Efficiency Estimates of Health Care Systems, Economic Papers No 549, *Directorate General Economic and Financial Affair*s (DG ECFIN), European Commission

Morris, S., M. Sutton & H. Gravelle (2005) Inequity and Inequality in the Use of Health Care in England: An Empirical Investigation, *Social Science & Medicine*, 60(6), 1251-1266

Murray, C. & J. Frenk (2000). A Framework for Assessing the Performance of Health Systems, *Bulletin of the World Health Organization* 78(6), Theme Papers, 717-731

Nguyen, N. C. Harvie,& S. Suardi. (2020). ASEAN Income Gap and the Optimal Exchange Rate Regime. *Applied Economics*, 52(3), 288-304.

Nuru. N. Y., (2019). The Dynamic Effects of Monetary Policy Innovations in Ethiopia. *African Journal of Economic and Management Studies*, 11(1), 169-180.

Oglobin, C. (2011) Health Care Efficiency across Countries: a Stochastic Frontier Analysis, *Applied Econometrics and International Development*, 11(1), 5-14

Over, M.A. (2004) *HIV/AIDS Treatment and Prevention in India: Modelling the Costs*. The World Bank.

Pandey, R. & V. M. Jessica. (2019). Determinants of Indian Housing Market: Effects And Counter Effects. *Property Management*, 38(2), 199-218.

Pasara, M. T., T. K. Mutambirwa, & N. Diko. (2020). The Tri-variate Causality among Education, Health, and Economic Growth in Zimbabwe. *Sustainability* 12(4), 1357.

Przywara, B. (2010) Projecting Future Health Care Expenditure at European Level: Drivers, Methodology and Main Results, *Economic Papers No 417, Directorate General Economic and Financial Affairs* (DGECFIN), European Commission

Ravallion, M.(2003).The Debate on Globalization, Poverty and Inequality. Why Measurements Matters. International Affairs, 79(4), 739-753

Reeves, A., S. Basu, M. McKee, C. Meissner & D. Stuckler (2013) Does investment in the health sector promote or inhibit economic growth? *Globalization and Health*, 9(1), 43

Rosko, M. D. & R. L. Mutter (2008) Stochastic Frontier Analysis of Hospital Inefficiency: a Review of Empirical Issues and an Assessment of Robustness. *Medical Care Research and Review*, 65(2), 131-166

Rossi, B. & Y. Wang (2019). Vector Autoregressive-based Granger Causality Test in the Presence of Instabilities. *The Stata Journal: Promoting Communications on Statistics and Stata* , 19(4), 883-899.

Shah, A. & J. Proach (2015) . Whole-Disease Model Approach: Methodologies and Challenges in Communicating The Economic Burden Of Rare Diseases, *Value in Health*, 18(3), A21-A22

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica*. January, 48(1), 1–48.

Sims, C. A.(1992) Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy. *European Economic Review*. June, 36 (5). 975–1011.

Simon, J., M. M. Hofmarcher-Holzhacker & N. Perić (2017). Health System Performance Assessment Landscape at the EU Level: a Structured Synthesis of Actors and Actions, *Archives of Public Health* 75(5)

Skirbekk, V. (2004) Age and Individual Productivity: A literature survey, *Vienna Yearbook of Population Research*, 133-153

Sobocki, P., B. Jonsson, J. Angst & C. Rehnberg (2006) Cost of Depression in Europe, *Journal of Mental Health Policy and Economics*, 9(2), 87–98

Spasova, S., D. Bouget & B. Vanhercke (2016) Sick pay and Sickness Benefit Schemes in the European Union, Background Report for the Social Protection Committee's In-depth Review on sickness benefits, *European Social Policy Network (ESPN), European Commission*

Stock, J. H. (1997) *Cointegration, Long- Run Co-movements, and Long-Horizon Forecasting, in Advances in Econometrics: Proceedings of the Seventh World Congress of the Econometric Society*, Volume III. David Kreps and Kenneth F. Wallis, eds. Cambridge: Cambridge University Press, pp. 34–60.

Stock, J.H & M.W. Watson (2001).Vector Autoregressions, *Journal of Economic Perspectives*, 15(4), 101-115

Stuckler, D., A. Reeves & M. Mckee (2017) Social and Economic Multipliers: What they are and why they are important for health policy in Europe, *Scandinavian Journal of Public Health*, 45.18_suppl, 17-21

Suhrcke, M., M. McKee, J. Mortensen, R. S. Arce & S. Tsolova (2005) *The Contribution of Health to the Economy in the European Union*, Luxembourg: Office for Official Publications of the European Communities

Tappenden, P., J. Chilcott, A. Brennan, H. Squires & M. Stevenson (2012).Whole disease modeling to inform resource allocation decisions in cancer: a methodological framework, *Value in Health*, 15(8), 1127-1136.

UNAIDS (2010) *UNAIDS Report on the Global Epidemic*. Published by UNAIDS

Varabyova, Y. and J. Schreyögg (2013) International Comparisons of the Technical Efficiency of the Hospital Sector: Panel Data Analysis of OECD Countries Using Parametric and Non-Parametric Approaches, *Health Policy*, 112(1), 70-79

Victora, C. G., L. Adair, C. Fall, P. C. Hallal, R. Martorell, L. Richter, H. S. Sachdev and Maternal and Child Under-nutrition Study Group (2008) Maternal and child under-nutrition: consequences for health and human capital, *The Lancet* 371(9609), 340-357

Vo, A. T. , C. M. Ho,& D. H. Vo (2019). Understanding the Exchange Rate Pass-through to Consumer Prices in Vietnam: the SVAR Approach. *International Journal of Emerging Markets*, 15(5), 971-989.

Watson, M. (1994) *Vector Auto Regressions and Cointegration, in Handbook of Econometrics*, Volume IV. R.F. Engle and D. McFadden (eds.). Elsevier Science Ltd., Amsterdam

White, J. (2013) Budget-makers and health care systems, *Health Policy*, 112(3), 163-171

Wichitaksorn, N. (2020) Analyzing Multiple Vector Autoregressions through Matrix-variate Normal Distribution with Two Covariance Matrices. *Communications in Statistics - Theory and Methods*, 49(8), 1801-1817.

Wilson, K. (2016) *Innovation and sustainability of European healthcare systems, Bruegel Blog*, 28 January, available at: http://bruegel.org/2016/01/innovation-and-sustainability-of-european healthcare- systems/

World Health Organization (2000) *The World Health Report 2000: Health Systems: Improving Performance*

World Health Organization (2005) European Strategy for Child and Adolescent Health and Development.

WHO[World Health Organization] (2014) *World Health Statistics 2014*

Yebaoh, M.A., M.O. Ansong; F.Appau-Yeboah; F.Y. Anyan; F.J.Gyebil, H.A. Antwi & E.Yiranbon (2014).Instrumental Variables Approach to Estimating the Continuing Effects of HIV/AIDS Epidemic on Global Development, *American International Journal of Contemporary Research*, 4(6), 1-22

Yong. E. L. (2019) Unemployment and the European Union, 2000–2017: Structural Exploration Of Distant Past Economic Experience and Future Prosperity. *Journal of Economic Structures*, 8(1)

Zha, T. (1998) *Dynamic Multivariate Model for Use in Formulating Policy, Economic Review, Federal Reserve Bank of Atlanta*, First Quarter, 1998.