The Effect of Healthcare Supply Chain Logistics Expenditures on Economic Growth

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The paper contributes to the literature by investigating possible dynamic relations between healthcare supply chain logistics expenditure and economic growth, measured by gross domestic product, in Uganda. By employing univariate and multivariate time series approach, the empirical results confirm the presence of a positive relationship between healthcare supply chain logistics expenditures and economic growth. After detecting unit roots in the data, cointegration test confirmed the presence of a long-run relationship between the two variables. In addition, the results for Granger Causality test suggested the existence of a unidirectional effect indicating that economic growth significantly influences healthcare supply chain logistics investment but healthcare supply chain logistics investment do not influence economic growth in Uganda over the studied period.

INTRODUCTION

Better healthcare is a primary human need. According to (WHO, 2001), 50% of economic growth differential between developed and developing nations is attributable to ill-health and life expectancy. Developed countries spend a high proportion of their gross domestic product (GDP) on healthcare supply chain logistics (HSCL) because healthier residents can serve as a major driver for economic activity and development, and reduction of poverty. The following studies have examined the role of healthcare expenditure in economic development and poverty alleviation, health, human capital and economic growth (Schultz, 1999; Sen, 1999; Ravallion and Chen, 1997; Sala-i-Martin, 1997; Barro, 1996; Barro and Sala-i-Martin, 1995; Squire, 1993; Mankiw et al., 1992; Levine and Renelt, 1992; and Lucas, 1988), and lifetime incomes of individuals (Anyanwu, 1998, 1996). Although the relationship between HSCL expenditure and economic growth is well established in the literature, the direction of causation of this relationship remains contentious (Kleiman, 1974; Newhouse, 1977; Hansen and King, 1996; Blomqvist and Carter, 1997; McCoskey and Selden, 1998; Gerdtham and Lothgren, 2000; Karatzas, 2000; Bloom, Canning and Sevilla, 2001; Arora, 2001; Bhat and Jain, 2004). In a seminal paper, Newhouse (1977, pp. 115-25) examined this relationship and confirmed earlier findings by Kleiman (1974), suggesting that a country's per capita GDP is the single most important factor influencing healthcare spending. This finding shaped the foundation for a large body of literature, which view income as a major determinant of expenditure for healthcare (Behrman, 1990, pp. 54-8; Barro and Sala-i-Martin, 1995; Bloom and Sachs, 1998) supply chain logistics. To the contrary, several studies have argued that healthcare does not play an important role in influencing productivity, concluding instead that health is not an important variable when it comes to explaining economic growth (Cullis and West, 1979, p. 84-89; Easterly and Rebelo, 1993, p. 417-58; Acemoglu and Johnson, 2006). Amidst the mixed evidence, recent studies (Gallup and Sachs, 2000; Getzen, 2000; Reinhardt, Hussey and Anderson, 2004) have employed modern analytical techniques and have produced new results that suggest a feedback effect between HSCL spending and GDP per capita. Therefore, the intent of this paper is to investigate possible dynamic relations between personal healthcare expenditure (PHE) and economic growth (GDP) in Uganda using univariate and multivariate time series analysis.

HEALTHCARE SUPPLY CHAIN LOGISTICS AND ECONOMIC GROWTH

An insightful review of the literature on the nature of links between healthcare and productivity (GDP) has been provided by Bhat and Jain (2004), Bloom and Canning (2005), Lo'pez-Casasnovas, Rivera and Currais (2005) and recently by Finlay (2007). While Bhat and Jain (2004) summarized the literature in several broad categories based on methodological techniques, Bloom and Canning (2005) and Lo'pez-Casasnovas et al. (2005) approached the literature from a micro and macroeconomic perspective; whereas Finlay (2007) breaks the literature into empirical and theoretical studies. On a microeconomic level, different health indicators have been used in the literature based on the idea that healthier workers are less susceptible to disease, more alert, more energetic, and consequently more productive and command higher earnings (Bloom and Canning, 2005; Lo´pez-Casasnovas et al., 2005). Notable studies include Grossman (1972), Muurinen (1982), Forster (1989), Ehrlich and Chuma (1990), Johansson and Lofgren (1995) and Meltzer (1997). Macroeconomic studies are based on a model in which economic growth during an interval of time is a function of initial income, economic policy variables, and other structural characteristics of the economy (Bloom and Canning, 2005; Barro and Sala-i-Martin, 1995; Bloom and Sachs, 1998; Bhargava, Dean, Jamison, Murray, 2001; and Gyimah-Brempong and Wilson, 2004). Additional evidence of the importance of healthcare for economic growth has been provided by international organizations. For instance, a report by the World Health Organization's Commission on Macroeconomic and Health demonstrates significant linkages of health with economic growth, and health and poverty (WHO 2001). Similarly, studies conducted by the Pan American Organization show long-term impacts of life expectancy on economic growth in Mexico and Latin American countries (Mayer-Foulkes, 2001a; Mayer-Foulkes, 2001b). These initiatives, besides generating an enormous amount of high quality research, have served to fill a void in the existing literature (Lo´pez-Casasnovas et al., 2005).

DATA COLLECTION

Government per capita HSCL expenditure data covering the period 1982-2006 were obtained from Fan, Zhang and Rao (2004) and the World Health Organization (WHO, 2007), while data on gross domestic product (GDP) for the same period were obtained from Global Econ data (EconStats, 2009).

TESTING FOR TRENDS

To account for the time structure of personal healthcare expenditure (PHE) and economic growth (GSP) variables, unit root tests are conducted using the Augmented Dickey-Fuller method; hereafter ADF (Dickey and Fuller, 1979, 1981; Davidson and MacKinnon, 1993). Whether or not to include the linear trend in conducting unit root tests is still contentious. For instance, McCoskey and Selden (1998) indicated that the ADF regressions should not include any linear trend, because the intercept itself already acts as a trend and power is lost in the case of a limited sample. To the contrary, Hansen and King (1998) argued that the time trend is evident for these variables and must be included to apply the ADF test in its general form. In this paper, unit root tests are performed with and without a linear trend. For the unit root test, the non-rejection of the null hypothesis would indicate that the series is characterized by a random walk (Dickey and Fuller, 1979; Davidson and MacKinnon, 1993).

Table 1 show the unit root test results for the level series, as well as their first differences. MacKinnon's critical values for testing the null hypothesis for the unit root at the 5 percent and 10 percent levels when a constant is included without a linear trend are -3.01 and -2.64, respectively. For the level series, the null hypothesis of the unit root cannot be rejected for personal healthcare expenditure and GDP series at both the 5 percent and 10 percent significance levels. For the first differences, the null hypothesis of the unit root is rejected for personal healthcare expenditure and GDP series at the 10 percent significance levels. This suggests that, the values of personal healthcare expenditure in Uganda are I(1), because their first differences are stationary. When a linear trend is introduced, MacKinnon's critical values for testing the null hypothesis for the unit root at the 5 percent and 10 percent levels when a linear trend is included are -3.63 and -3.25, respectively. Similarly, the null hypothesis of the unit root cannot be rejected for the level series but rejected for the first differences for PHE and GDP series at the 5 percent significance levels; implying that the series are I(1).

Table 1. Augmented Dickey-Fuller (ADF) Test Results

	Levels	1st Differences	10% Critical Value	5% Critical Value
No Trend				
PHE	1.62(1)	-2.79*(1)	-2.64	-3.01
GDP	1.73(1)	-2.82*(0)	-2.64	-3.01
With Trend				
PHE	-0.95(1)	-5.43**(1)	-3.25	-3.63
GDP	-2.17(1)	-3.76**(0)	-3.25	-3.63

*, ** indicates significance at 10% and 5% levels, respectively
( ) indicate number of lags

COINTEGRATION ANALYSIS

Next, cointegration analysis is conducted based on the ADF test. To accomplish this, the Engle-Granger two-step test is employed. If a series Y_t is non-stationary and there is a β vector (or matrix) such that $W_t = \beta' Y_t$ becomes stationary, then Y_t is considered cointegrated and the vector β is called the cointegrating vector (Engle and Granger, 1987). Previously in Table 1, it was shown that both PHE and gross state product series (GDP) are I(1). Thus, these non-stationary series can be written as a linear combination of stationary and non-stationary series as:

$$\begin{aligned} PHE_t &= a_{11}\phi_t + a_{12}\varpi_t \\ GDP_t &= a_{21}\phi_t + a_{22}\varpi_t \end{aligned} \tag{1}$$

where ϕ_t and ϖ_t represent the unit root and stationary component, respectively.

Since each component of the bivariate series includes the nonstationary component ϕ_t, both components of Y_t are nonstationary. However, if the coefficients $(a_{ij}, i, j = 1,2)$ are known, then

$$PHE_t - \frac{a_{21}}{a_{11}} GDP_t = \left(a_{22} - \frac{a_{21}a_{12}}{a_{11}} \right) \varpi_t = c\varpi_t \tag{2}$$

is stationary and the system is cointegrated with the cointegrating vector $\beta = \left(-\frac{a_{21}}{a_{11}}, 1 \right)'$. Since we do not know the coefficients, we normally need to estimate all the coefficients in equation (1). But now, it is sufficient only to estimate the ratio $\frac{a_{21}}{a_{11}}$ using OLS (Engle and Granger, 1987**)**. The differenced series in (2) look like the residuals from the regression of PHE_t on GDP_t, and hence if the residual series is stationary, then the bivariate series is cointegrated. Moreover, the OLS estimator of the parameter PHE_t obtained from that regression is a consistent estimator for the ratio $\frac{a_{21}}{a_{11}}$. The results for the cointegration equations when GDP_t is regressed on PHE_t and vice-versa are reported in Table 2.

Table 2. Cointegration Regression

	β-Coefficient	**t-Ratio**	**D-W Test**	**R-Square**
PHE Regressed on GDP	50.77*	12.03	0.34	0.86
GDP Regressed on PHE	0.017*	12.03	0.37	0.86

* Denotes significance at 1% level

To check for cointegration, the errors from the cointegration equations in Table 2 are recovered to perform nonstationarity tests since cointegration requires stationary residuals (Engle and Granger, 1987). To do that, the following equation is specified:

$$\Delta\varepsilon_t = \varpi\varepsilon_{t-1} + \sum_{i=1}^{p}\psi_i\Delta\varepsilon_{t-i} + \eta_t \tag{3}$$

where ε_t is the error from the cointegration equation, η_t is a stationary random error; here the null hypothesis of nonstationarity is rejected when ϖ is significantly negative. The summation runs to 'p' where p is 2. Table 3 reports the ADF test statistics and the critical values. As shown in Table 3, the null hypothesis of non-stationary of the residuals is rejected at the 5 percent significance level for both personal healthcare expenditure and GDP series. Thus, the cointegration results suggest a long-run relationship between PHE and GDP over the study period.

Table 3. ADF Test on Residuals

	Statistics	**5% Critical Value**
PHCE Regressed on GDP	-4.14**	-3.63
GDP Regressed on PHCE	-4.29**	-3.63

** Denotes significance at 5% level

TESTING FOR CAUSALITY

The interrelationship between personal healthcare expenditure and GDP can be more directly examined using causality test. By incorporating time lags between these variables, this approach is particularly relevant because changes in personal health care expenditure typically my not cause changes in economic growth immediately, but rather over several periods and vice-versa. The standard Granger causality test (Granger, 1969) examines whether past changes in one variable, y, help to explain current changes in another variable, x, over and above the explanation provided by the past changes in x. If not, then one concludes that y does not Granger causes x. To determine whether causality runs in the other direction, from x to y, one simply repeats the experiment, but with y and x interchanged. Four findings are possible: 1) neither variable Granger causes the other; 2) y causes x, but not vice versa; 3) x causes y, but not vice versa; and 4) y and x Granger causes each other (Granger, 1969).

The estimated Granger causality test is based on the following regression (Granger, 1969):

$$\Delta PHE_t = \alpha_0 + \sum_{i=1}^{m}\beta_i\Delta PHE_{t-i} + \sum_{i=1}^{m}\delta_i\Delta GDP_{t-i} + \varepsilon_t \tag{4}$$

where Δ is the first-difference operator and ΔPHE and ΔGDP are stationary time series. The null hypothesis that GDP does not Granger causes PHE is rejected if the coefficients δ_i in equation (4) are jointly significant based on the standard F-test. The null hypothesis that PHE does not Granger causes GDP is rejected if the β_i s are jointly significant in equation (4), when ΔPHE_t replaces ΔGDP_t as the left-hand side variable (Granger, 1969). Table 4 reports the F-statistics for the standard Granger causality tests of whether personal health care expenditure causes economic growth or vice versa.

At the conventional 5 percent significance level, the standard causality tests suggest that we cannot reject the null hypothesis that personal healthcare expenditure does not Granger causes economic growth. As for the null hypothesis that GDP does not Granger causes personal health care expenditure, the null hypothesis is rejected, implying the non existence of a feedback effect between GDP and personal healthcare expenditure in Uganda. Since the null hypotheses that GDP does not Granger causes personal health care expenditure is rejected at the conventional 5 percent significance level while the null hypothesis that personal health care expenditure does not Granger causes GDP cannot be rejected at the conventional 5 percent significance level, it can be concluded that Uganda's GDP Granger causes personal health care expenditure, but not vice versa.

Table 4. Pair wise Granger Causality Tests

Null Hypothesis:	F-Statistic	Probability
PHE does not Granger Cause GDP	0.114	0.893
GDP does not Granger Cause PHE	3.63*	0.047

* Denotes significance at 5% level

CONCLUSIONS AND IMPLICATIONS

Government expenditure on HSCL is imperative for better health which in turn drives economic growth, sustainable development, and poverty alleviation. Thus, an attempt was made to find the direction of the causal relationship between PHE and economic growth, measured by GDP, in Uganda. The empirical results of univariate and multivariate time series analysis suggest a strong relationship. The findings are consistent with literature. Gyimah-Brempong and Wilson (2004) reported a positive nexus between expenditure in health and economic growth in Sub-Saharan African and OECD nations. WHO (2001) found that improving life at birth by mere 10% can contribute to economic growth by 0.35% per year. Bloom and Canning (2003, 2000) argued that individuals with better health can impact economic activity and development in a number of ways, including increase in productivity at work and incomes, improved longevity in the workplace, improved investment in their own education, and enhanced savings because of the expectation of a longer life. In addition, healthier individuals do not only work more effectively and efficiently, but they also contribute more time to productive economic activities (Anyanwu and Erhijakpor, n. d). After detecting unit roots in health care expenditures and GDP, we were able to find cointegration. This finding is contrary to earlier country studies (Hansen and King, 1996; Blomqvist and Carter, 1997) that were not able to find cointegration in general, as a long run relationship after detecting unit roots in healthcare expenditure and GDP. The results for Granger Causality test suggested the existence of a unidirectional effect indicating that GDP Granger causes PHE, but not vice versa.

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