

Determinants of Public Health Expenditure in Ghana: A Cointegration Analysis

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Abstract This paper examines the determinants of public healthcare expenditure in Ghana using annual time series data from 1970 to 2008. The paper explored the stationarity and cointegration properties between public healthcare expenditure, and environmental and socio-economic indicators using ERS optimal point unit root test, and Engle-Granger cointegration tests. By this, we examined the long-run impacts of real GDP, CO₂ emissions, crude birth rate, life expectancy, inflation, and urbanization on public healthcare expenditure in Ghana. FMOLS technique was applied to estimate the long run multipliers of public health expenditure model. The results of the paper show that public health expenditure in Ghana is positively affected by real GDP, policies that aim to improve healthiness of the population as measured by life expectancy and crude birth rates. We find strong evidence that healthcare is a necessity in Ghana. These variables need more and critical attention to achieve improved healthcare.

Keywords: *ghana, public health expenditure, cointegration, life expectancy, crude birth rate*

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1. Introduction

Healthcare is a very essential commodity to all humanity. It is the means through which a person is maintained pursuant to illness. In recent years, life expectancy has improved. People are living longer than before, due to improved living standards, advanced health technology, and among others [1] and people's expectations on healthcare have risen due to the development and the technological progress in the sector. Healthcare needs are therefore increasing due to the current nature of working and life styles which have rendered many people less active physically. Obviously, as healthcare needs rise, one would expect expenditure on health to also rise to cater for the needs of the people. In most industrialized economies, health expenditure has been rising faster than the growth of income, for instance, health expenditure in the European (EU), Organization for Economic Co-operation and Development (OECD), and G7 countries has been rising sharply [2]. The unending debate sparked by [3] study on the causes of growth in public health expenditure continues among scholars, policy makers, etc. This stems from the fact that they wanted to control the growth of health expenditure by examining the factors causing its rise.

On the contrary, in developing countries of which Ghana is not an exception, there appears to be a low level

(declining trend) of government expenditure on health. This makes the prospects of achieving some minimal level of adequacy in healthcare services to remain a challenge for most people in developing countries due to extreme poverty. Most researchers and studies like [4] argue that government health expenditure in sub-Saharan Africa is insufficient to tackle the ever growing health needs (caused by malaria, HIV/AIDS, Bruli Ulcer (BU), non-communicable diseases etc). These funding gaps have been attributed to some economic policies such as the structural adjustment programs, rising poverty levels and the increasing scale of health problems [5].

International agencies like the United Nations (UN) and the World Bank recognize that developing countries, including Ghana, can reduce poverty and fight major diseases (malaria, HIV/AIDS) through substantial spending in the health sector [6,7]. It is well recognized that many governments are trying to control and contain healthcare cost. However, the ramifications of low levels of health spending are more adverse on vulnerable groups made up of women, children, aged, and disabled among others [5].

In Ghana, public health expenditure has been fluctuating since the 1970s. For example, in 1995, expenditure on health care services was estimated to be about 3% of the country's Gross Domestic Product (GDP). As given by the World Bank development indicators (WDI) (2010) public health expenditure for the year 1996

through 2004 was below 3% of GDP. As at 2008, government or public health spending was 3.2% of GDP, an amount that is inadequate for a country full of poor people and rising aging population. In spite of Ghana's population growing averagely at a rate of about 3% per year since 2000 [8], government health spending has not been matched to that effect since the average has been less than 3% of GDP. A significant proportion of Ghanaians lack access to quality healthcare services, particularly rural dwellers, despite some amount of investments in providing health facilities. This limits people's access to health care services leading to inequities. Healthcare is very essential if Ghana is to achieve the MDGs by 2015 and attain a higher middle-income status. These points have been buttressed by [9], and [10] that healthy persons devote more time to productive activities resulting in higher aggregate output.

Improving the health status of the citizenry may also have the potential to increase government spending on the sector. Also, government's ability to manage healthcare expenditure partly depends on obtaining accurate estimates of the underlying factors explaining healthcare expenditure in Ghana. Our objective for this paper is to investigate the determinants of public (government) health expenditure in Ghana since the factors determining such expenditure pattern have not been given the needed attention. Thus, to best of our knowledge, no study of such nature has been conducted on Ghana.

2. Literature Review

There is an extensive and rich literature on what determines the quantity of resources that a nation devotes to the medical needs of its population, and the debate continues to expand. This section of the paper reviews some of the literature.

According to [2], expenditure generally arises as a result of consumer and producer choices underlying demand and supply. By this, [2] argues that a person's demand for healthcare would depend on his/her health status, income, price of healthcare, and sometimes health insurance. Thus, in general a person's demand for health care is not only dependent on price, private budgetary considerations or his ability to pay [11]. Also, [12] has argued that in investigating the factors determining public health expenditure there exist some "usual suspects" like ageing, growth in output, healthcare resources e.g. hospital beds, staff, etc, new technologies and medical progress as well as the healthcare system in operation. Most researchers, clinicians, and politicians consider the belief that healthcare costs rise steeply with age is as a common knowledge but [13] found aging to be associated with higher healthcare consumption.

Again, studies by Grossman [13,14,15], etc. observed slight correlation between income and the utilization of health care, though [3] found that over 90 percent of the variation in per capita health expenditure is explained by variation in per capita GDP. However, [16] have argued that health expenditure also has an explanatory power on GDP which is usually dubbed "reverse causation" thus variations in GDP could also be attributed to health expenditure patterns due to the fact that healthy population increases productivity. Similarly, [17] findings support the

arguments that changes in per capita GDP have a significant effect on healthcare resources. Again, they found urbanization and education to be important variables for the determination of health expenditure.

Reference [18] and [19] found national income growth to be significant input of public health expenditure. In Netherlands, [20] found, with the use of Vector Auto regressions (VAR), public infrastructure investment exerted a positive influence on public health expenditure. Also, in Chile, an empirical study by [18] showed that healthiness as measured by life expectancy was a major determinant of public health expenditure. Reference [2] also posits that high rates of public revenue and expenditure growth is expected to induce high spending on health care. In Pakistan, [21] found that share of health expenditure in total public expenditure, literacy rate, and GDP to be a major cause of the variations in public health expenditure. They also found crude birth rate and foreign aid to be very important determinants of public health expenditure but only in the short run.

Further, [22] finds evidence that GDP and environmental factors like pollution impact positively on public health expenditure in three provinces in China after they used panel unit root and cointegration analysis. Also in Turkey, [23] finds long run relationship between public health expenditure and GDP, and population growth after testing the stationarity and co-integration of healthcare expenditure. The proportion of the population over the age of 65, degree of urbanization, GDP, and number of hospital beds are key determinants of public health expenditure [24].

Following from the literature, and as indicated by [2], relevant literature has identified seven sources of determinants of the public health expenditure (either per capita or total): income (per capita); demographic factors, such as the age structure of the population, the trend in public spending, often approximated by the share of public expenditure on GDP, the healthcare structure of the country, as displayed by medical and nursing manpower, hospital beds, etc.; non-medical health determinants, such as life style, consumption of tobacco and alcohol, calorific intake etc.; social characteristics, such as the distribution of income, distribution of education, skills, jobs, opportunities and expectations for the future; the health status and health improvement of the population, such as life expectancy and infant mortality. It should however be noted that macroeconomic indicators such as inflation, exchange rates, interest rates could also affect public health expenditure. The objective of the paper is to find the determinants of health expenditure in Ghana using the modern co-integration approach.

3. Methodological Techniques

3.1. Model Specification and Data

Deriving from the public health expenditure literature reviewed, we model public health expenditure by incorporating income, environmental, demographic, and macroeconomic indicators among other things as follows:

$$PhExp = \varphi + \beta_1 RGDP + \beta_2 LEXP + \beta_3 CBR + \beta_4 INF + \beta_5 Rup + \beta_6 CO_2 + \beta_7 Urp + \varepsilon_i \quad (1)$$

In order to be able to estimate the model, equation 1 was specified as follows in their logarithmic form. This was to ensure that the variables were in common units. The operational model is:

$$PhExp = \varphi + \beta_1 LnRGDP + \beta_2 LnLEXP + \beta_3 LnCBR + \beta_4 LnINF + \beta_5 LnRup + \beta_6 LnCO_2 + \beta_7 LnUrp + \varepsilon_i \quad (2)$$

Where φ is the intercept, $PhExp$ is public health expenditure measured in current Ghana cedis, $RGDP$ is income (proxied by annual real Gross Domestic Product), $LEXP$ is the degree of healthiness of the population measured in terms of life expectancy, CBR (crude birth rate) is the annual number of births per 1000 population, CO_2 captures environmental pollution from factories and households (measured in total CO_2 emissions in kt), Urp is urbanization and is measured in terms of the population living in urban areas while Rup is population living rural areas. Finally, INF is the general price level in the economy (i.e. inflation rate) and it is included to capture the impact of macroeconomic stability in the economy. As already specified, the variables enter the empirical estimation and analysis in natural logarithmic form.

The study expects that growth in GDP would influence health expenditure positively. This is because as income rises, the nation is more able to spend on healthcare services hence the positive sign of income or GDP. According to [5], public health expenditure falls when the overall degree of healthiness of the people is high or rising. Thus, higher quality of life as measured in access to quality drinking water, pollution-free environment, proper sanitation among others improves health of the people thereby raising life expectancy. This reduces healthcare consumption. However, for government to maintain or improve the healthiness of the population public expenditure on healthcare services have to be increased and this is documented by [25] hence the sign of β_2 is unknown a priori. Urbanization comes with it many social problems since it entails overcrowding, stress-related illness, pollution, crime and among other things. Majority of Ghanaians live in urban centers and usually most of these urban dwellers live in overcrowded and unsanitary conditions [8]. This has the potential to deteriorate the health of affected population leading to higher consumption of healthcare. It is therefore expected that $\beta_7 > 0$. Environmental deterioration has been found to be very detrimental to human health and is well documented by [26,27,28,29]. The deterioration in human health resulting from environmental degradation like pollution increases healthcare consumption, which positively affect public health expenditure. We therefore postulate that $\beta_6 > 0$. Birth rate, rural populations and macroeconomic instability (inflation) are expected to be positive and so are their coefficients, i.e. $\beta_3 > 0$, $\beta_4 > 0$ and $\beta_5 > 0$.

This study makes use of annual time series data covering the periods 1970 – 2008. We obtained data from several sources including the World Development Indicators (2010), the state of the Ghanaian economy (various volumes), and various World Bank reports on Ghana concerning structural adjustment programs as well as budget statements of the Government of Ghana.

3.2. Methods of Analysis

In this study, the time series econometric techniques involved three important steps. The first step was the

determination of the time series properties of the variables. The purpose was to determine the order of integration of each of the variables, i.e. the number of times a variable is differenced to achieve stationarity or the non-stationarity nature of the variable. By this, we conducted a unit root test to ensure that the logarithmic form of the variables exhibited a stationary process using the Elliot Rothenberg and Stock (ERS) point optimal unit root test. The ERS point optimal test tests the null hypothesis that a time series y_t is $I(1)$ against the alternative that it is stationary at an asymptotically optimal point assuming that the dynamics in the data have an ARMA structure. The ERS test is modification of the ADF tests in which the data are detrended so that explanatory variables are “taken out” of the data prior to running the test regression. For example, let the general ADF regression be represented in the form:

$$\Delta y_t = \alpha y_{t-1} + x_t' \delta + \sum_{j=1}^p \Psi_j \Delta y_{t-j} + \varepsilon_t \quad (3)$$

Under the null hypothesis, y_t is $I(1)$ which implies that $\alpha = 1$. The ERS define a quasi-difference of y_t that depends on the value, say a , representing the specific point alternative against which we wish to test the null:

$$\partial(y_t|a) = \begin{cases} y_t & \text{if } t = 1 \\ y_t - ay_{t-1} & \text{if } t > 1 \end{cases} \quad (4)$$

The ERS point optimal test is therefore based on quasi-differencing regression so as to give efficient estimates concerning the behavior of the series. The quasi-differenced regression is in the form:

$$\partial(y_t|a) = \partial(x_t|a)' \delta(a) + \eta_t \quad (5)$$

The second step in our econometric methodology was to determine the existence a long run equilibrium relationship among the variables in the model specified in equation (2). To achieve this, the Engle-Granger test for cointegration proposed by [30] was conducted. The underlying assumption of cointegration is that if two or more series are $I(1)$ series, then there exist a possibility of their residuals exhibiting a stationary process, i.e. $I(0)$. Therefore, equation (2) was estimated using ordinary least square techniques (OLS). Further, the residuals from this OLS regression was tested for stationarity using the ERS unit root test. There is evidence of cointegrating relationship between public health expenditure and the explanatory variables presented in the model if the residuals exhibited stationary process. The implication is that a linear combination of the variables in the study will follow a stationary process hence convergence to a long-run equilibrium is possible.

The final step in the econometric technique has to do with the estimation of the long run equilibrium multipliers or elasticities. We adopt the fully modified OLS (FMOLS) due to [31] to estimate the long run equilibrium elasticities. This is because the FMOLS employs a semi-parametric correction to eliminate the problems caused by the long-run correlation between the cointegrating equation and stochastic regressors innovations, and therefore presents an asymptotically unbiased and fully efficient estimates. The FMOLS is also applicable to models with full rank, i.e. $I(1)$ and even stationary regressors [32]. Thus, FMOLS allows both $I(1)$ and $I(0)$ regressors (a situation

we may encounter) in the same equation, hence our choice of FMOLS for the present study is appropriate.

4. Empirical Results

4.1. Unit Root and Cointegration Tests

The results of the unit root test are presented in Table 1 below. The results indicate that the variables considered in this study are a mixture of stationary $I(0)$ and non-stationary $I(1)$ regressors. The log of crude birth rate and urbanization variables were stationary after their first differencing, i.e. $I(1)$, both with and without trend terms. The remaining series were also stationary at their levels (log levels) both with and without trend terms. The results are summarized in Table 1 below

Table 1. Summary of ERS unit root test results (order of integration)

Series	intercept	intercept & trend
LNPHEXP	I(0)	I(0)
LNRGDP	I(0)	I(0)
LNLEXP	I(0)	I(0)
LNCBR	I(1)	I(1)
LNINF	I(0)	I(0)
LNRUP	I(0)	I(0)
LNCO ₂	I(0)	I(0)
LNURP	I(1)	I(1)

The results of the cointegration test based on the Engle-Granger test for cointegration approach are presented in Table 3. Indeed, [33] contend that a linear combination of variables integrated to different orders may not yield a stationary series. However, [34] argues that given the problems associated with the testing procedures for cointegration, if the chosen set of variables (dependent and independent) cointegrate among themselves so as to produce a stationary residual, there is no need to worry about the degree of integration of the individual variables. This supports our choice of estimator which allows for inclusion $I(1)$ and $I(0)$ processes in the same equation to estimate long run elasticities. As indicated earlier, an OLS regression of public health expenditure was estimated using the variables presented and the residuals from this OLS regression was tested for stationarity using the ERS unit root test. There was strong evidence of cointegration relationship between public health expenditure and the explanatory variables presented in the model. The implication is that, a linear combination of the variables will follow a stationary process hence convergence to long-run equilibrium is possible.

Table 2. Unit Root test under Engle-Granger test for cointegration

Variable	ERS unit root test (Order of integration)
Residual Series from OLS	I(0)

4.2. FMOLS Regression

The results of the cointegration regression based on FMOLS are presented in Table 3. Out of the seven variables presented in the model, only three of the variables were statistically significant to exert strong impact on public health spending in the long-run for Ghana.

Table 3. FMOLS Estimates for Public Health Expenditure in Ghana

Series	Coefficient	t-value(s)
LNRGDP	0.073406	0.0043***
LNLEXP	64901076	3.2802***
LNCBR	1.19	4.4916***
LNINF	536250.60	1.4900
LNRUP	134.8730	1.2091
LNCO ₂	18650.50	0.9598
LNURP	-43.32570	-0.7116

$R^2 = 0.93$, Adj. $R^2 = 0.92$

***(**)* denote rejection of the null hypothesis of no level effect at 1%, 5% and 10% respectively

The empirical results in Table 3 are robust and satisfactory as well. The regression had a coefficient of determination of about 92% adjusted for the degrees of freedom. This means that about 92% of the variations in public health spending in Ghana could be attributed to the explanatory variables presented and therefore presents a good fit of the regression model. This reinforces the existence of a long-run linear relationship among public health spending, crude birth rate, CO₂ emissions, real GDP, life expectancy, urbanization, inflation and rural populace. Their signs showed as expected except the variable urbanization that had signs different from expected. The positive sign of life expectancy suggest that policies that aim to cause an improvement in life expectancy tend to raise public health spending in the long run since this variable was statistically significant at 1% error level. This finding, though not consistent with the findings of [5], supports arguments raised by [25]. This is because as the government tries to improve the healthiness of the population, then it must spend more on the health sector in order to achieve these gains. It is implied that improvement in the overall health of the citizens is because of increased spending in the sector.

Real GDP was statistically significant and is positive on public health spending in Ghana within the study period though its coefficient is very low. This also confirms the findings of [2,21,22,23] that increases in national income has a positive long run effect on public health spending. The implication is that increases in real GDP tend to raise public expenditure in the long run. Thus as Ghana's real GDP rises, it has the potential to spend extra more on the health sector of the economy. However, the very low elasticity suggests that Ghana tends to spend a small portion of her income on healthcare. The coefficient of real GDP also suggests that healthcare in Ghana is a necessity for the people.

Again, crude birth was significantly positive on public health expenditure within the period under study at 1% error level and consistent with the findings of [21] that policies that aim to spur the number of births raises public health spending. Thus, as the number of births per 1000 people rises, it tends to impact positively on public health spending in the future. This is particularly true as it may cause population growth and presents many policy implications for Ghana. Another variable of particular interest is pollution as proxied by CO₂ emissions in the country. Though it was not statistically significant, its positive sign is very important and also consistent with [22] findings that pollution has the potential to spur public health spending. The implication is that air pollution increases public health spending but at small levels. The non significance level of this variable could be due the fact that there are not enough factories in Ghana as the

level of industrialization is low hence emissions from industries would be low.

In addition, the empirical results show that rural settlements and population living in rural areas increases public health spending though this was not statistically significant. Thus, government increases spending to provide health services for those living in rural areas by providing the necessary infrastructure. However, this was not the case for urban centers. Urbanization in the case of Ghana tends to reduce government spending on health services. This is because urban centers have adequate health infrastructure. Also, the people in these urban areas have improved incomes as compared to those in the rural areas and are able to afford health. This reduces the pressure of government. Macroeconomic conditions proxied by inflation were not statistically significant to exert much pressure on public health spending though its sign was consistent with a priori expectation. Inflation has no significant long run effect on public health spending in Ghana.

5. Conclusion and Policy

The above results have very useful implications for policy formulations regarding public health expenditure and investment in Ghana. The results lend credence to the fact that policies that aim to raise real GDP in the Ghanaian economy would be very beneficial to government investment in the health sector. Also, policies aimed at improving life expectancy or the overall healthiness of the population would cause an increase in public health spending. Thus, government policies that aimed to spur a growth in life expectancy would induce higher investment in the health sector. Further, crude birth rate has a significant positive long run relationship with public health spending and investment. The implication is that policies (e.g. free maternal care) that have the potential to spur growth in the number of births per 1000 people would cause substantial investment in the health services. Given the rapid growth of population in Ghana, it is imperative for government to increase its spending on the health sector in order to have efficient health system. Indeed, it can be concluded that, socio-economic factors play an important role in determining health care expenditure in Ghana.

Real GDP, Life expectancy and crude birth rate were the most significant variables affecting public health expenditure in Ghana. Real GDP is also an essential variable, which exhibit a positive relationship with public healthcare expenditure. Though not statistically significant, the positive signs of pollution, inflation and percentage of the population living in rural areas are very key factors to watch regarding public health expenditure determination in the near future. As noted earlier, this study was basically conducted to find out the drivers of public health expenditure in Ghana using data covering the periods between 1970 and 2008.

In conclusion, there is find strong evidence that national income, life expectancy, and crude birth rate are the key determinants of public health spending, and that healthcare is a necessity but not a luxury commodity (as in most advanced economies). As a necessity, much effort should be made by government to make it available to all

irrespective of location, age, gender, religion or tribe, social or economic status of the individual.

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References

- [1] Tang, S., Tao, J., & Bekedam, H. (2012) Controlling cost escalation of healthcare: making universal health coverage sustainable in China, *BMC Public Health* 2012, 12 (Suppl. 1): S8, <http://www.biomedcentral.com/1471-2458/12/S1/S8>.
- [2] Hitiris, T. (1999) Health Care Expenditure and Cost Containment in the G7 Countries, Discussion Papers in Economics, No. 1999/15, University of York.
- [3] Newhouse, J. P. (1977), Medical-Care Expenditure: A Cross-National Survey, *Journal of Human Resources*, 12, 115-25.
- [4] Bokhari, F. A. S, Gai, Y., and Gottret, P. (2007) Government health expenditures and health outcomes. *Health Economics*, Vol. 16, Issue 3 (2007), pp. 257-273.
- [5] Oaikhenan, H. E. & Umoru, D. (2012) Determinants of public health investment in Nigeria. In O. Olaniyan, L. Akani Olayinka & Olalekan Olubajo (Eds.), *Economics of health system governance and financing in Nigeria*, (1st Ed., pp. 149-164). Ibadan University Press.
- [6] UN (2001). African summit on HIV/AIDS, tuberculosis and other related infectious diseases: Abuja declaration on HIV/AIDS, tuberculosis, and other infectious diseases. New York: United Nations, 2001. http://www.un.org/ga/aids/pdf/abuja_declaration.pdf (accessed 18/07/2013).
- [7] WHO (2001) WHO Commission on Macroeconomics and Health. *Macroeconomics and health: investing in health for economic development*. Geneva: World Health Organization, 2001. <http://whqlibdoc.who.int/publications/2001/924154550x.pdf> (accessed 18/07/2013)
- [8] Ghana Statistical Service (2012) 2010 Population and Housing Census, Summary of Final Results.
- [9] Anyanwu, J. C. and Erhijakpor, A. E. O. (2007) Health Expenditures and Health Outcomes in Africa, *Economic Research Working Paper, No 91 (December 2007)*.
- [10] Gyimah-Brempong, K, and Wilson, M. (2004), Health Human Capital and Economic Growth in Sub-Saharan African and OECD Countries, *The Quarterly Review of Economics and Finance*, Vol. 44, No. 2, pp. 296-320.
- [11] Pauly, M. (1986) Taxation, Health Insurance and Market failure in the Medical Economy, *Journal of Economic Literature*, 24, 629-75.
- [12] Busse, R. (2001) Expenditure on Health Care in the EU: Making Projections for the Future Based on the Past, *The European Journal of Health Economics*, Vol. 2, No. 4 (2001), pp. 158-161.
- [13] Grossman, M. (1972), On the concept of health capital and demand for health, *Journal of Political Economy*, Volume 80, No. 2, pp. 223-225.
- [14] Muurinen, J. M. (1982) Demand for health: A generalized Grossman Model. *Journal of Health Economics*, Volume 1, No. 1, pp. 5-28.
- [15] Wagstaff, A. (1986) The demand for health: Some new empirical evidence, *Journal of Health Economics*, Volume 5, No. 3, pp. 195-233.
- [16] Rivera, B., & Currais, L. (1999), Economic growth and health: direct impact or reverse causation?, *Applied Economics Letters*, 6, 11, 761-764.
- [17] Siddiqui, R., Usman, A. and Rashida, H. (1995) Determinants of expenditure on health in Pakistan, *The Pakistan Development Review*, Volume 34, No. 4, pp. 959-970.
- [18] Costa, J. S., Ellson, R. W. & Martin, R. C. (1987) Public Health Capital and national Output: Some Empirical Evidence, *Journal of Regional Science*, 27 (3): 419-437.
- [19] Deno, K. T. (1988) The Public Health Capital and Manufacturing Output, *Southern Economic Journal*, 55 (1): 400-411.

- [20] Sturm, J. E. (1998) Public capital spending in The Netherlands: development and explanations, *Applied Economics Letters*, 5:5 - 10.
- [21] Toor, I. A. and Butt, M. S. (2005) Determinants of Health Care Expenditure in Pakistan, *Pakistan Economic and Social Review*, Vol. 43, No. 1 (Summer 2005), pp. 133-150.
- [22] Zheng, X., Yu, Y., Zhang, L., and Zhang, Y. (2010) Does pollution drive up public health expenditure? A Panel Unit Root and Cointegration Analysis, available at <http://www.hanqing.ruc.edu.cn/admin/uploadfile/201005/20100520103320946.pdf> (accessed: 18/07/2013).
- [23] Kiyamaz H., Akbulut, Y., and Demir, A. (2006) Tests of stationarity and cointegration of health care expenditure and gross domestic product. An application to Turkey, *The European Journal of Health Economics*, Vol. 7, No. 4 (Dec., 2006), pp. 285-28.
- [24] Wang, Z. (2009) The determinants of health expenditures: evidence from US state-level data, *Applied Economics*, 41(4), 429-435.
- [25] Novignon, J. Olakojo, S. A, Nonvignon, J. (2012) The effects of public and private healthcare expenditure on health status in sub-Saharan Africa: new evidence from panel data analysis, *Health Economics Review* 2012, 2: 22.
- [26] Pearce, D., and Turner, K.R. (1991). Economics of natural resources and the environment. John Hopkins Press, Baltimore.
- [27] Neidell, M. J., 2004. Air pollution, health and socio-economic status: the effect of outdoor air quality on childhood asthma. *Journal of Health Economics* 23, 1209-1236.
- [28] Mead, R.W., and Brajer, V., (2005) Protecting China's children: valuing the health impacts of reduced air pollution in Chinese cities. *Environment and Development Economics* 10, 745-769.
- [29] He, J. (2008) Industrialization, environment and health: the impacts of industrial SO₂ emission on public health in China. *Chinese Journal of Population, Resources and Environment* 6, 14-24.
- [30] Engle, R. F and Granger, C. W. J. (1987) Co-integration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 55, 251-276.
- [31] Phillips, P. C. B. and Hansen, B. E. (1990) Statistical Inference in Instrumental Variables Regression with I(1) Processes," *Review of Economics Studies*, 57, 99-125.
- [32] Adu, G. (2012) Studies on Economic Growth and Inflation: Theory and Empirics, Doctoral Thesis No. 2012:14, Swedish University of Agricultural Sciences, Sweden.
- [33] Engle, R. F and Granger, C. W. J. (1991) Long-run Economic Relationships: Reading in Cointegration, Oxford University Press, 1991.
- [34] Muscatelli, V. A, and Hum, S. (1992) Cointegration and Dynamic Time Series Models, *J. of Economics Surveys* 6, 1-43.

Notes on Data Sources

Except public health expenditure, all data used were obtained from World Development Indicators (2010). Data on public health expenditure was compiled from the World Bank Report No. 4702-GH (Ghana, Policies and Program for Adjustment, Volume 2: Statistical Appendix, October 3, 1983), and Government of Ghana Budget Statements (1992-2008) as well as State of the Ghanaian Economy reports (1991, 1992).