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Effect of Health Expenditure on Child Health in Sub-Saharan Africa: Governance Perspective

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Abstract
Though child mortality in Sub-Saharan Africa has declined since 2000, they are still higher than other regions of the world. This has provided impetus for increasing effectiveness of health expenditure through improved quality of governance in the health sector. Dynamic panel estimation method was used to estimate panel data for 41 SSA countries for the period 2000 to 2009. The results show that public health expenditure relative to private health expenditure led to fall in under-five mortality rates in SSA. When corruption was controlled for effectiveness of public health expenditure on reducing under-five mortality was evident. Additionally, regional variations in effectiveness of health expenditure on under-five mortality was also realized. SSA countries are likely to benefit from reduced corruption which has an impact on effectiveness of health expenditure on child health outcomes.
Keywords: Health Expenditure Child Health SSA Corruption

1. Background

Promotion of good health for children has featured prominently in international agenda. For instance, one of the Millennium Development Goals (MDGs) is to reduce child mortality rates by two-thirds in the developing world by 2015 (United Nations, 2000). However, this target is unlikely to be met (United Nations, 2011). Healthy children attain more education, high labour productivity as adults and therefore enhance economic growth (Amiri and Gerdtham, 2013; Belli, 2005; Stenberg, et al. 2014; DSAED, 2010). This potential benefit provides an impetus for provision of adequate health services to the children.

Since 1990, under-five mortality rates have declined across the world. Over the period 2000-2011, average under-five mortality rates across the world declined by 30% compared to 16% during the period 1990-2000 (Table 1). However, compared to other regions of the world Sub-Saharan Africa (SSA) had the highest under-five mortality rates. Additionally, large differences were observed in under-five mortality rates within SSA. West and Central Africa had the highest under-five mortality rate (132) compared to Eastern and Southern Africa (84) in 2011. Thus, despite the decrease in some countries SSA is far from achieving the MDG to lower under-five mortality rates by two-thirds in 2015. Only Botswana, Cape Verde, Eritrea, Ethiopia, Liberia, Madagascar, Malawi, Mauritius, Niger, Rwanda, Senegal, Tanzania and Zambia might achieve the MDG target.

Table 2 provides a summary of the factors that may have contributed to the decline in under-five mortality rates in SSA and corresponding quantitative indicators. The decrease in under-five mortality rates during the period 2000-2011 coincided with increases in public health spending in some SSA countries. A possible reason for the increase in health spending maybe the Abuja Declaration of 2001 that sought to increase public health spending in SSA. At the same time, there has been increased donor funding of health programmes from US$ 1.4 billion in 2002 to US$ 8.7 billion in 2010 (Wexler, et al., 2013). These interventions have reduced death from malaria (World Health Organization, 2011); Measles and Pertussis; infectious diseases such as Cholera; and from HIV/AIDS related illnesses (UNAIDS, 2012).Other factors which might have influenced the reduction in under-five mortality rates in the period 2000-2011 are as follows. Growth in the real income per capita which improved standard of living and access to resources (Houweling et al., 2005; Anyanwu and Erhijakpor, 2007; Yaqub, et al., 2012). Improved literacy levels for mothers improves their capacity and enables them to consume and access quality health care for their children (Anyanwu and Erhijakpor, 2007). Increased participation of women in labour force enhances their earning power, therefore influencing household quality of life through good nutrition (Farag, et al., 2013). Improved quality of governance through reduced corruption levels is likely to result in efficient use of resources in the health sector (Gupta et al., 2000; Yaqub, et al., 2012).

Despite reduction in under-five mortality rates in SSA from 154 per 1000 live births in 2000 to 109 per 1000 live births in 2011, under five mortality is relatively high in SSA compared to other regions where the rates are below 100 (UN Inter-Agency, 2012). Unless the under-five mortality rates in SSA are reduced, there are likely to affect negatively the human capital reserve and future economic gains in SSA. However, research evidence on the factors that reduce under-five mortality rates is inconclusive (Novignon, et al., 2012).

Public health expenditure is a key policy instrument expected to reduce under-five mortality rates

(Anyanwu and Erhijakpor, 2007). However, previous studies relating health expenditure to reduction of child mortality have been inconclusive. Anyanwu and Erhijakpor (2007), Novignon, et al. (2012) and Issa and Ouattara (2005) found that in SSA increasing health expenditure would significantly reduce child mortality rates. Studies of other regions and those of developing countries have also provided similar evidence (Farahani, et al., 2010; Bhalotra, 2006; Houweling, et al., 2005; Muldoon, et al., 2011; Farag, et al., 2013). However, some studies did not find significant link between health expenditure and child mortality (Gupta, et al., 1999; Yaqub, et al., 2012; Gani, 2008). Thus the issue of whether public health spending has an impact on under-five mortality is still not settled.

It has been argued that poor governance is a possible explanation for ineffectiveness of public spending to reduce under-five mortality rates (Rajkumar and Swaroop, 2008). In particular, high corruption levels are likely to cause inefficiency in health service delivery. This involves embezzlement of funds, health staff absenteeism, and irregular procurement due to bribery and kickbacks, drugs and equipment pilferage and in kind payments (Lewis, 2006a; Savedoff, 2006). The average corruption perception index for Sub-Saharan Africa was 3.02 (out of a scale of 1 to 10) for the period 2000-2009 indicating that corruption is a problem in SSA (Teorell, et al, 2011). A very small number of studies examine the effect of good governance in improving child health. These studies suggested that good governance can reduce child mortality directly and by enhancing the effectiveness of public health expenditure (Yaqub, et al., 2012; Rajkumar and Swaroop, 2008; Gupta, et al., 2000; Farag, et al., 2013).

Most studies of the impact of health expenditure on child mortality do not take into account dynamics. Some have used ordinary least squares OLS (e.g. Houweling, et al., 2005; Rajkumar and Swaroop, 2008; Yaqub, et al., 2012) while others use static panel data models (e.g. Novignon, et al., 2012; Farag, et al., 2013). Few studies have examined whether the impact of health expenditure on child mortality depends on the quality of governance, that is, the interaction between health expenditure and governance. It is also not known how the effect of health expenditure on child mortality varies within SSA regions. Such information is necessary for understanding problems arising from poor governance and how they affect effectiveness of health expenditure. Additionally, investigating differences in the effectiveness of health expenditure in SSA region may provide a platform for region specific solutions to reduce child mortality.

The main aim of this study is to examine the relationship between health expenditure and under-five mortality and the role of governance environment within which health spending occurs in Sub-Saharan Africa. Specifically, this study estimates the impact of health expenditure and under-five mortality in SSA; tests whether effect of health expenditure on under-five mortality in SSA depends on level of corruption; examines whether there are regional differences in the relationship between health care spending, level of corruption and under-five mortality in SSA. This study provides new evidence on relationship between health expenditure and under-five mortality in the post Abuja declaration era. With exception of Novignon, et al. (2012) who used static models there is limited literature on relative effects of public and private health expenditure on child mortality in SSA. Other existing studies such as Anyanwu and Erhijakpor (2007) focus only on the effects of total and public health expenditure on under-five mortality. The current study departs from existing studies in SSA by using panel data to examine the effects of corruption and how corruption levels influence effectiveness of health expenditure on under-five mortality.

The relevance of the study arises from the fact that reduction of child mortality in SSA is a priority agenda in policy makers' perspective. The MDG goal on reducing child mortality to a third of 1990 levels is still being implemented till 2015 and is not likely to be met by many SSA countries. Furthermore, reduction in under-five mortality is necessary for human capital stock, future investments and future workforce availability. Policy makers are therefore likely to benefit from the knowledge of how health expenditure has impacted on child mortality since the Abuja declaration on public health expenditure. This provides an impetus for assessment of success of the policy in improving child health in SSA over the last decade. Understanding how quality of governance especially levels of corruption has affected child mortality directly and its impact on effectiveness of public health expenditure provides a platform for controlling corruption in the health sector.

Furthermore, existing studies of the impact of health expenditure on under-five mortality rates have not examined the potential regional heterogeneity across SSA sub-regions. Given varied policies and health systems the effectiveness of health expenditure on under-five mortality in SSA is likely to differ across sub-regions. This study provides evidence on these differences. Increasing interest in regional integration makes comprehension of regional variations in effectiveness of health expenditure and quality of governance on reduction of child mortality in SSA relevant. This contributes to policy prescriptions that are focused on solving regional specific concerns on health expenditure, levels of corruption and child mortality. Unlike previous studies for SSA this study used a larger sample. The application of the linear dynamic panel model (GMM-IV) is a departure from previous studies that use OLS, fixed effects and random effect estimators. The dynamic GMM-IV technique introduces dynamics, control for endogeneity and heterogeneity as well as ensuring stationarity. Hence more robust estimates than in the other static panel models are achieved. This study is a benchmark for future research in SSA on health expenditure, corruption and child mortality. This is through expansion of the subject matter within region analysis (Eastern Africa, Western Africa, Central Africa and Southern Africa). Research can focus on differences in income grouping and how they allocate resource to the health sector. This is likely to inform policies relevant to reduction of under-five mortality in the long-run. Research can also focus on measures of corruption in the health sector and how it affects child mortality and effectiveness of public health expenditure when such data become available.

The remainder of this paper is organized as follows; section 2, presents the literature review. Section 3, outlines the methodology used in the paper. Section 4, presents the descriptive statistics and econometric results. Section 5, presents a summary, conclusion and policy implications.

2. Literature Review

Several studies have examined the relationship between different categories of health expenditure and child mortality using different types of data and estimation methods. The results differ across studies. Some studies found no effect of health expenditure on child mortality (e.g. Gupta, et al., 1999 (total health expenditure); Gupta, et al., 2001 (private health expenditure)). Others found limited effect (e.g. Filmer and Pritchett, 1999) and yet others have found strong effect of health expenditure on child mortality (e.g. Houweling, et al., 2005; Bokhari, et al., 2007; Baldacci, et al., 2003; Anyanwu and Erhijakpor, 2007; Novignon, et al., 2012) .

The first strand of literature are the cross-sectional studies relating health expenditure and child mortality. These studies include Houweling, et al. (2005), Bokhari, et al. (2007), Baldacci, et al. (2003), Gupta, et al. (1999; 2001), Filmer and Pritchett (1999) and Gottret and Schieber (2006). Houweling, et al. (2005) examined the effects of public health expenditure on under-five mortality rates in a sample of 43 countries in Africa, Asia and Latin America with emphasis on differential impact among the rich and poor. OLS estimates indicated that a 10% increase in public health expenditure per capita would decrease under-five mortality rates by about 1.1% (rich) to 2.4% (poor). The weakness of this study emanates from not accounting for potential endogeneity of health expenditure in the under-five mortality equation which could occur because of reverse causality.

Using a sample of 127 developed and developing countries, Bokhari, et al. (2007) studied the link between per capita public health expenditure and under-five mortality rates. Unlike Houweling, et al. (2005) the paper controlled for endogeneity of health expenditure and real per capita GDP by using instrumental variable generalized method of moments-Heteroscedastic OLS estimator (GMM-HOLS) and Heteroscedastic Two-stage Least Squares (GMM-H2SLS). The estimated elasticities imply that a 1% increase in per capita public health expenditure reduced under-five mortality by 0.34% and 0.52% for developed and developing countries respectively. Though the study used GMM models the type of data used does not account for dynamics.

Baldacci, et al. (2003) estimated the relationship between 3-year (1996-1998) averages in public health expenditure and both infant and under-five mortality rates for 94 developing and transition economies. To account for potential endogeneity of health expenditure and heteroscedasticity in the cross-sectional data, Weighted Two stage Least Squares (WTSLS) was used. The cross-section results indicated that an increase in public health expenditure by 1% resulted in decline of under-five mortality rate by about 0.22%. For the infant mortality rate, a rise in public health expenditure by 1% reduced it by 0.13% to 0.22% across three estimation methods (OLS, 2SLS and WTSLS). Baldacci, et al. (2003) also treated health status (infant and under-five mortality) as a latent variable and used covariance structure model to determine its relationship with government health expenditure. They found insignificant relationship between health expenditure and both infant and under-five mortality. Even when the income group of a country was taken into consideration, the coefficient of public health expenditure was still insignificant in the health status equation. The authors argued that such a model is appropriate as health status is multidimensional and unobservable and cannot be measured by health indicators.

Similarly, Gupta, et al. (1999) applied OLS and 2SLS to investigate the effects of total health spending and public spending on primary health care (public expenditure on clinics and practitioners or on preventive health) on under-five mortality rates in 50 developing countries and transition economies. They found that an increase in primary health care expenditure by 1% reduced under-five mortality rates by 0.97% and 0.95% respectively. The estimation results also indicated that total health expenditure as percent of GDP did not significantly affect under-five mortality rates. The authors identified two weakness of the study. First, non-uniform definition of primary health expenditure across countries. Second, potential correlation between the control variables measles immunization rates and adult illiteracy. Furthermore, due to inconsistencies in data the sample size used was far below the initial 50 observations (30 in OLS and 29 in 2SLS) this leaves very few degree of freedom which may affect robustness of the estimates realised in the study.

In another study, Gupta, et al. (2001) examined the separate effects of public and private health expenditure on under-five mortality rates among the poor and non-poor households in 70 countries. The OLS estimates showed that an increase in public health expenditure per capita by 1% reduced under-five mortality rates by between 0.3% to 0.32% in the poor households. But private health expenditure had insignificant effect. For the non-poor households, the results indicated that an increase of 1% in public and private health expenditure per capita led to a decline in under-five mortality rates by 0.23% and the range of 0.28% to 0.43% respectively. Just as the Houweling, et al. (2005) study, the paper does not account for endogeneity of health expenditure and under-five mortality. Filmer and Pritchett (1999) like Gupta, et al. (1999) applied OLS and 2SLS to examine the impact of public health spending on child and infant mortality using cross-section of 98 countries. The OLS estimates showed that an increase in public health expenditure by 1% led to a fall in under-five mortality by 0.14% at 10% significance level indicating a weak link. However, once the potential endogeneity of health expenditure was addressed through 2SLS, the effect of health spending on child mortality was insignificant. The authors do not include the effects of private health expenditure on under-five mortality. Gottret and Schieber (2006) used several methods (OLS, Heteroscedastic OLS, 2SLS and generalized method of moment Heteroscedastic 2SLS) to investigate the relationship between government health expenditure and under-five mortality rates in 2000 for 113 countries. The OLS estimates indicated that increase in government health expenditure by 1% reduces under-five mortality by 0.17%. This result is lower than those which controlled for endogeneity (2SLS and GMM-H2SLS) which ranges from 0.34% to 0.4%. One of the cross-sectional studies focusing on effect of corruption on provision of health services is Gupta, et al. (2000). The study analysed data averaged for the period 1985-1997 for each of 128 developed and developing countries using OLS and 2SLS. The OLS baseline estimates indicated that unit increase in corruption levels raised child mortality and infant mortality by 0.37 and 0.35 per 1000 live births respectively. When level of corruption was conditioned on income, the impact of corruption increased under-five and infant mortality by 0.13 and 0.14 per 1000 live births respectively. When endogeneity was accounted for through 2SLS unit increase in corruption levels raised child mortality by 0.10 per 1000 live births respectively. The authors concluded that lowering corruption was essential for better health outcomes.

The overall results from the cross-sectional studies are inconclusive. Some studies (Houweling, et al., 2005; Baldacci, et al., 2003; Bokhari, et al., 2007; Gupta, et al., 1999; Gottret and Schieber, 2006; Gupta, et al., 2001) have found a reducing and significant effect on under-five mortality. On the other hand, some studies such as Filmer and Pritchett (1999) even after controlling for endogeneity found insignificant relationship between public health expenditure and child mortality. In addition Gupta, et al. (2001) found insignificant link between private health expenditure and under-five mortality while Gupta, et al. (1999) found insignificant relationship between total health expenditure and under-five mortality. Gupta, et al. (2000) found a significant increase in child mortality and infant mortality when level of corruption is high. The estimated magnitudes of the effects of health expenditure on child mortality vary widely across the studies reviewed. In cross-sectional studies temporal dynamics are not accounted for because of their one period nature.

The second strand of literature are studies that used time series data to determine the relationship between health expenditure and under-five mortality. Time series studies provide a trend and temporal perspective. Such studies can be used to project future patterns of behaviour of both health expenditures and child mortality. Anand and Ravallion (1993) examined the impact of public health expenditure per capita and infant mortality rate in Sri Lanka. They used data for 1952-1981. OLS estimates showed that increasing public health expenditure per capita by 1% reduced infant mortality by about 0.33%. However, this study neither controlled for potential endogeneity of public health expenditure in the infant mortality equation nor examined the time series properties of the data used. Thus the estimated relationship maybe spurious. Yaqub, et al. (2012) estimated the impact of public health expenditure and governance on under-five mortality rates in Nigeria using OLS and 2SLS. The study covers 1980 to 2008. They estimated the direct effect of public health expenditure on under-five mortality and the interaction effect between public health expenditure and corruption levels. Without the interactive variable the OLS and 2SLS estimates indicate that increasing public health expenditure by 1% increases under-five mortality rates by 0.03% and 0.05% respectively. In the model with the interactive variable, the level of corruption significantly reduced under-five mortality and the interaction between public health expenditure and level of corruption is positive and significant. In the 2SLS, increasing public health expenditure by 1% at the mean of corruption level (0.78) in Nigeria raises under-five mortality rates by 0.01%. The study used small sample (30 observations) such that with several explanatory variables few degrees of freedom are available for statistical inferences. The paper does not also examine the time series properties of the data. Thus the estimation results maybe spurious. In general time series studies do not control for unobserved heterogeneity. Second, the studies focus on a single country or region. This may impede generalisation of the study results to other countries.

The third strand of studies used panel data. The use of panel data to analyse the effect of health expenditure on child mortality presents some advantages over both cross-sectional and time series data. With panel data the number of observations increases and it is also possible to control for unobserved country specific effects.

One category of panel data studies related total and public health expenditure effects on child mortality (Anyanwu and Erhijakpor, 2007; Baldacci, et al., 2003; Gani, 2008). Anyanwu and Erhijakpor (2007) focused on health expenditure and under-five mortality rates in Africa. The study used a panel of 47 countries for the period 1999-2004. The authors applied three estimation methods, robust Ordinary Least Squares (ROLS), and robust Two-stage Least Squares (R2SLS) to account for endogeneity and fixed-effect estimator to account for unobserved heterogeneity. The paper found that an increase of 10% in per capita total health expenditure would decrease under-five mortality rates by the range of 1.7% to 6.3%. Additionally, an increase in public per capita health expenditure by 10% would reduce under-five mortality rates by the range of 1.8 % to 2.5% across the three estimation methods.Applying a fixed effects model to data from seven Pacific Islands, Gani (2008) examined the effects of per capita public health expenditure on infant and under-five mortality for selected periods between 1990 and 2002. The fixed effects estimation was corrected for auto-regression of order one. The study found an insignificant relationship between per capita public health expenditure and under-five mortality. On the other hand, increasing per capita public health expenditure reduced infant mortality by 0.66%. This study did not control for potential endogeneity of health expenditure. The size of the sample used was small (n=28) such that with 12 explanatory variables few degree of freedoms for hypothesis testing are left. Baldacci, et al. (2003) estimated the impact of public health expenditure on under-five mortality using two estimators; feasible generalised least squares (FGLS) and Arellano-Bond GMM-IV. The results for FGLS and Arellano-Bond indicated that an increase in public health expenditure by 1% reduced under-five mortality rates by 0.28% and 0.14% respectively. But FGLS estimates showed that increasing public health expenditure by 1% increased infant mortality by 0.06%. The strength of this study is that it accounts for dynamics and potential endogeneity of health expenditure in the under-five mortality equations estimated by GMM.

Another category of panel data studies consider the impact of public and private health expenditure on health outcomes (example, Freire and Kajiura, 2011; Novignon, et al., 2012). Freire and Kajiura (2011) examined the link between components of health expenditure and under-five mortality in Asia-Pacific countries. A Fixed effects model was estimated using panel data for the period 1990-2009. The authors found that a 1% rise in public health expenditure reduced under-five mortality rates by 0.06%. A 1% increase in private health expenditure reduced under-five mortality rates by 0.10%. However, the study does not account for potential endogeneity of public and private health expenditure in the estimated under-five mortality equation. Similarly, Novignon, et al. (2012) studied the effects of public and private health care expenditure on infant mortality rates in a panel of 44 Sub-Saharan Africa countries for the period 1995-2010 using fixed effect model. The results indicated that a 1% increase in total health expenditure reduced infant mortality by about 3 per 1000 live births. The results further show that increasing public and private health expenditure by 1% reduced mortality rates by 4.2 and 2.5 per 1000 live births respectively. A drawback of these results is that potential endogeneity of the health expenditure variables in both infant and under-five mortality equations was not taken into account.

A third group of panel data studies examined the effect of governance measures on health outcomes (Rajkumar and Swaroop, 2008; Farag, et al., 2013; Hu and Mendoza, 2013). This emerging literature examined the role of governance environment on the effectiveness of health expenditure. Rajkumar and Swaroop (2008) investigated the relationship between public health expenditure and under-five mortality rates and how governance (corruption and quality of bureaucracy) affects the relationship. The study used a three year panel data (1990, 1997, and 2003) covering 91 developed and developing countries. Pooled OLS estimates indicated that a 1% increase in public health expenditure reduced under-five mortality by 0.18%. In the equation containing the interaction of public health expenditure and level of corruption, the public health expenditure estimate is insignificant while the interaction variable is negative and significant. However, the estimates may be biased as potential endogeneity of health expenditure in the child mortality equation was not controlled for. In Farag, et al. (2013) a link between health expenditure, infant and child mortality, and the role of governance in low and middle income countries is investigated. The paper applied fixed effect method of estimation to a panel of 133 countries for the years 1995, 2000, 2005 and 2006. The estimates showed that a 1% increase in total health expenditure reduced under-five mortality by the range of 0.15% to 0.38%. On the other hand, it lowered infant mortality by the range of 0.13% to 0.33%. Increasing government health expenditure reduced under-five mortality by a percentage ranging from 0.1 to 0.19 while private health expenditure reduced it from the range of 0.07% to 0.08%. Additionally, a rise in government health expenditure by 1% led to a decline in infant mortality ranging from 0.08% to 0.17%, while increasing private health expenditure by 1% reduced infant mortality by the range of 0.05% to 0.07% respectively. The estimation results indicated that improving the level of government effectiveness[1] reduced child mortality. The full effect of government health expenditure with respect to improved government effectiveness (evaluated at the mean) led to a reduction of under-five mortality ranging from 0.07% to 0.12%. However, the fixed effect estimator does not take into account potential endogeneity of health expenditure in both infant and under-five mortality equations. Hu and Mendoza (2013) applied both fixed effects and 2SLS methods to investigate the link between public health expenditure and child mortality for 136

[1] *Is a variable that measures the ability of the government to implement socially sound policy, that is, the level and quality of public service provision and smooth function of the bureaucracy (Kauffmann and Kraay, 2006; Farag, et al., 2013).*

countries over the period 1960 to 2005. In the fixed effect model, a 1% increase in public health expenditure as a share of GDP reduced under-five mortality by 0.11%, while the interaction of public health expenditure and control of corruption was insignificant. Fixed effects estimates showed corruption coefficient was insignificant. The 2SLS was used to handle potential endogeneity of public health expenditure. The estimated effect however, was not significant.

The literature on the relationship between health expenditure and child mortality has not yet come to a consensus. The problem arises because of uncertainty in the estimated effects of public health expenditure. The uncertainty can be attributed to use of different data types, inconsistent data, accounting or not accounting for endogeneity of health expenditure and unobserved heterogeneity in the methods of estimation. This study contributes to the debate by using a rich panel data set for SSA and linear dynamic panel model. It estimates the impact of various measures of health expenditure (total, public and private health expenditure) and governance on under-five mortality rates. The study also examines regional variations in how health expenditure and its interaction with governance affects under-five mortality in SSA.

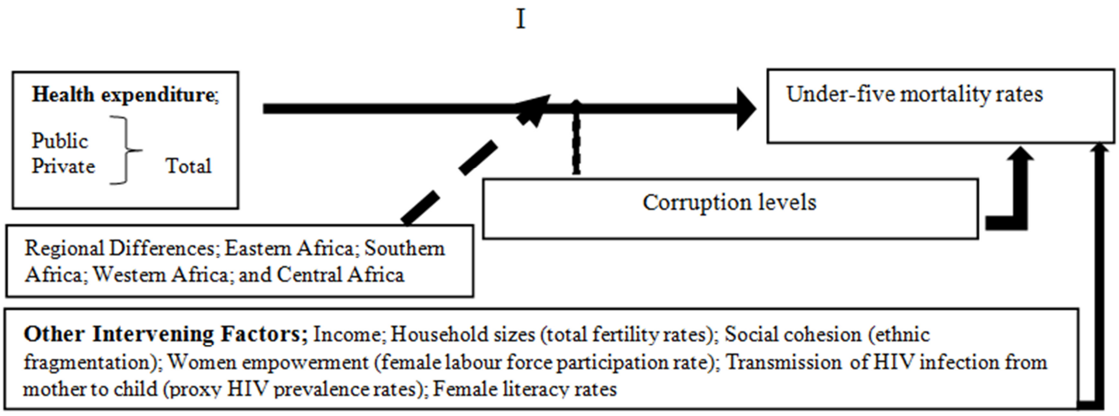
3. Methodology

3.1 Conceptual Model for Health Expenditure, Corruption and Child Health

Conceptually health spending is a function of the health system which enables the purchase of health goods and services. Increased allocation of health resources (especially, financial resources) by the government and private sector is likely to influence the quality of health service delivery. The conceptual model is summarized in Figure 1.

The improved health service delivery results in incremental effect on the quality of life and health capital to the beneficiaries (Grossman, 1972). This in turn leads to low mortality rates in children. Suppose the government invests the increased financial resources in child immunization (for instance, Measles); HIV/AIDS health programmes such as behavioural change education, antiretroviral therapy (ART), provision of condoms and post-exposure prophylaxis; or family planning services to reduce fertility rates.

Figure 1: Conceptual Model for Health Expenditure, Corruption and Under-Five Mortality



Source: Author (motivated from theoretical models of; Rajkumar and Swaroop (2008), Filmer and Pritchett (1999) and Yaqub, et al., 2012).

Curbing corruption increases transparency and accountability, thereby increasing effectiveness of health resources allocated to health. Lewis (2006a) identified issues such as absenteeism of health staff, bribery for services, leakage such as stealing of medical supplies as constituting most of the corruption in the health sector. Suppose we consider, the continuous presence of staff in the health care facilities, availability of drugs in the clinics would improve service delivery. This improved health service delivery would improve health of the beneficiaries which would lead to low child and adult mortality. Reduced embezzlement and diversion of health funds to other non-priority areas is likely to improve effectiveness of health spending. This is because the resources are employed where they are most needed. This would result in adequate health services which would eventually lead to low mortality rates.

Regional differences may also influence effectiveness of health expenditure in reduction of adult mortality. This is because they have varied health policies and priorities which are likely to influence child and adult health in different ways. The regions in the conceptual model are Eastern Africa, Western Africa, Southern Africa and Central Africa which are classified using United Nation country classification system (United Nations Statistics Division, 2013).

3.2 Theoretical Model

The health production function for estimating the relationship between health expenditure, corruption and child health is adapted from Rajkumar and Swaroop (2008), Filmer and Pritchett (1999) and Yaqub, et al. (2012). The relationship can be expressed as follows.

$$CH = f\,(HEXP, RGDPC, COR) \quad (3.1)$$

Where CH is under-five mortality rates. $RGDPC$ is real Gross Domestic Product per capita (real income per capita); $HEXP$ is health spending (total, public and private health care spending). COR is the level of corruption. A is assumed to be technological changes, which are assumed to be constant. From Equation (3.1) the model assumes that; increase in real per capita GDP leads to a reduction in under-five mortality rates. The mechanisms through which real income per capita affects child health are: allocation of more financial resources to child health services. Health expenditure influences child health through the following channels: availability of child health focused interventions such as immunization, nutrition boosters and supplements and, child growth monitoring. Health expenditure also facilitates availability of adequate health workers, drugs and medical supplies and infrastructure (clinics and hospitals) for provision of the child health related health services. Improving quality of governance by reducing corruption leads to a decline in under-five mortality rates. Low corruption environment is likely to promote transparency and accountability in provision of health services. Hence, reducing leakages which might affect effectiveness of health service delivery to children.

Model (3.1) is transformed in a Cobb-Douglas health production model. The production function relates health status with health spending and real gross domestic product (GDP) per capita. It is augmented with corruption variable and this relationship is expressed as equation (3.2).

$$CH_{it} = A(RGDPC_{it})^{\alpha} * (HEXP_{it})^{\beta} * (COR_{it})^{\sigma} \quad (3.2)$$

Taking the logarithms of equation 3.2 transforms it into a linear equation (3.3).

$$\ln CH_{it} = \ln A + \alpha \ln RGDPC_{it} + \beta \ln HEXP_{it} + \sigma \ln COR_{it} \quad (3.3)$$

The parameters are defined as follows: α is the coefficient of real GDP per capita; which measures the elasticity of under-five mortality rates with respect to change in income. β is the elasticity of under-five mortality rates with respect to change in health expenditure and σ is the elasticity of under-five mortality rates with respect to change in level of corruption. In equation 3.3 additional assumption is taken into consideration. The study assumes that some part of health spending (total, public and private) is lost or wasted due to corruption. This wastage has consequences on the effectiveness of health spending in a given country or region.

Following Yaqub, et al. (2012) and Pritchett (1996) and assuming $\theta(.)$ is a part of resources allocated to health that is spent on productive purposes, the β coefficient of health spending on, say programme k takes the form;

$$\beta = \pi(.) * \beta_k \quad (3.4)$$

Where β_k represents the productivity of public or private capital that is created from spending on health programme k. Assuming that $\pi(.)$ measures the effectiveness of health spending which is a function of level of corruption COR_{it}, then,

$$\pi = \theta_0 + \theta_1 COR_{it} \quad (3.5)$$

Substituting equations (3.4) and (3.5) into (3.3) results into the following equation;

$$\ln CH_{it} = \ln A + \propto \ln RGDPC_{it} + \beta_k(\theta_0 + \theta_1 COR_{it}) \ln HEXP_{it} * + \sigma \ln COR_{it} \quad (3.6)$$

Breaking down equation (3.6) leads to equation (3.7)

$$\ln CH_{it} = \ln A + \propto \ln RGDPC_{it} + \beta_1 \ln HEXP_{it} + \beta_2 COR_{it} * \ln HEX_{it} + \sigma \ln COR_{it} \quad (3.7)$$

Where β_1 is the coefficient of the log of health expenditure and β_2 is the coefficient of the interaction of corruption index and log of respective health expenditure.

3.3 Empirical Models

In order to investigate the impact of health expenditure on under-five mortality rates, three models are specified. The first model contains health expenditure and a set of control variables. This is the baseline model to study the relationship between health expenditure and under-five mortality rates. It is written as follows.

$$\ln CH_{it} = \alpha_0 + \alpha_1 \ln HEXP_{it} + \ln Z_{it}'\Psi + \mu_{it} \quad (3.8)$$

The model in equation (3.8) was extended to include the corruption perception index to yield the following model.

$$\ln CH_{it} = \tau_0 + \tau_1 \ln HEXP_{it} + \tau_2 \ln COR_{it} + \ln Z_{it}'\Psi + v_{it} \quad (3.9)$$

In order to investigate how level of corruption influences the effect of health expenditure on child mortality equation (3.9) was extended with interaction between health expenditure and corruption, to yield.

$$\ln CH_{it} = \gamma_0 + \gamma_1 \ln HEXP_{it} + \gamma_2 \ln COR_{it} + \gamma_3[COR_{it} * \ln HEXP_{it}] + \ln Z_{it}'\Psi + \varepsilon_{it} \quad (3.10)$$

The equations (3.8), (3.9) and (3.10) relates natural log of under-five mortality rates ($\ln CH_{it}$) to the natural log of health expenditure ($\ln HEXP_{it}$), the natural log of corruption index ($\ln COR_{it}$), the interaction between the natural log of health expenditure and corruption index ($COR_{it} * \ln HEXP_{it}$), and a vector of control variables. Z_{it} are control variables which include: the natural log of real GDP per capita, total fertility rates, HIV

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prevalence rates, the natural log of ethnic fragmentation, measles immunization rates, the natural log of female literacy and female labour force participation rate.

The coefficients α_1, β_1 and γ_1 are the coefficient estimates of health spending and are expected to be negative. β_2 and γ_2 are coefficients of level of corruption and are expected to be negative. γ_3 is the coefficient of the interaction term and can take positive or negative sign. Ψ is the coefficient for the vector of control variables. μ_{it}, v_{it} and ε_{it} are the composite error terms which consists of country specific effects and time-specific effects. The composite error terms are assumed to be normally distributed and homoscedastic.

In order to investigate regional differences in effects of health expenditure and corruption on under-five mortality rates equations (3.8), (3.9) and (3.10) are extended to include dummy variables of SSA sub regions and their interactions with health expenditure and level of corruption.

The baseline model to test for regional differences in the effects of total health expenditure on under-five mortality rates is written as follows.

$$lnCH_{it} = \alpha_0 + \alpha_1 lnHEXP_{it} + \alpha_2 EA_i + \alpha_3 CA_i + \alpha_4 WA_i + \alpha_5[EA_i * lnHEXP_{it}] + \alpha_6[CA_i * lnHEXP_{it}] + \alpha_7[WA_i * lnHEXP_{it}] + ln Z'_{it}\Psi + \kappa_{it} \quad \text{..........(3.11)}$$

When level of corruption and interactions with the regional dummy variables are included the model is as follows.

$$lnCH_{it} = \beta_0 + \beta_1 lnHEXP_{it} + \beta_2 EA_i + \beta_3 CA_i + \beta_4 WA_i + \beta_5[EA_i * lnHEXP_{it}] + \beta_6[CA_i * lnHEXP_{it}] + \beta_7[WA_i * lnHEXP_{it}] + \beta_8 lnCOR_{it} + \beta_9[EA_i * lnCOR_{it}] + \beta_{10}[CA_i * lnCOR_{it}] + \beta_{11}[WA_i * lnCOR_{it}] + ln Z'_{it}\Psi + \omega_{it} \quad (3.12)$$

Further extension introduces interaction between regional health expenditure and corruption to obtain the following model.

$$lnCH_{it} = \gamma_0 + \gamma_1 lnHEXP_{it} + \gamma_2 EA_i + \gamma_3 CA_i + \gamma_4 WA_i + \gamma_5[EA_i * lnHEXP_{it}] + \gamma_6[CA_i * lnHEXP_{it}] + \gamma_7[WA_i * lnHEXP_{it}] + \gamma_8 lnCOR_{it} + \gamma_9[EA_i * COR_{it} * lnHEXP_{it}] + \gamma_{10}[CA_i * COR_{it} * lnHEXP_{it}] + \gamma_{11}[WA_i * lnCOR_{it} * lnHEXP_{it}] + ln Z'_{it}\Psi + \varrho_{it} \quad \text{...(3.13)}$$

Equations (3.11), (3.12) and (3.13) relates natural log of health expenditure, regional dummy variables Eastern Africa (EA), Central Africa (CA), Western Africa (WA), interaction of regional dummy variables and natural log of health expenditure, interactions of regional dummy variables and natural log of level of corruption and the interactions of regional dummy variables, levels of corruption and natural log of health expenditure. The Southern Africa (SA) dummy variable and its interactions are dropped from the model to avoid the dummy variable trap. κ_{it}, ω_{it} and ϱ_{it} are composite error terms for the respective equations.

3.4 Estimation

Health expenditure could be potentially endogenous in under-mortality equations in the presence of measurement errors, omitted variables and reverse causality. For instance, economic adjustments, changes in population characteristics and political regime changes or upheavals are likely to be omitted variables correlated with health expenditure. Other concerns are problems of unobserved heterogeneity and lagged dependent variable in dynamic models. Estimation under these statistical challenges can produce inconsistent and biased estimates. Therefore an econometric strategy based on dynamic panel estimators was used to allow for instrumental variables. Specifically, the Generalized Method of Moments instrumental variable linear dynamic panel model was used. Linear Dynamic Panel Data (LDPD) is a hybrid model emanating from works of Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). It combines the properties of the Arellano-Bond GMM and Systems GMM estimators. The specified models were estimated using instruments in both differences and levels. Diagnostic tests for validity of instruments (Sargan test), overall significance of explanatory variables (Wald test) and autocorrelation (Arellano-Bond tests) were carried out. Table 3 shows the variable and the source of data.

4. Empirical Results

4.1 Descriptive Statistics

In Table 4 the mean under-five five mortality rate was 114.9 per 1000 live births across 41 SSA countries. The average public health spending was about US$ 759 million (2000, constant). Average private health care spending was higher at US$ 1,130 million. This shows that total health care spending at US$ 1,890 million, would hide the observation that private health expenditure is almost one and half times public health expenditure. Out-of-pocket health spending is the largest component of private health care spending. In 28 countries, it is about 70% of private health care spending. This suggests that many inhabitants of SSA are vulnerable to poverty when faced by high health expenditures. Mean Corruption Perception Index was 3.02. Because a corruption index of one denotes high corruption and corruption index of ten denotes low corruption, a corruption index of three indicates that corruption was rampant in most of the SSA countries over the period covered.

Average real GDP per capita was US$ 3,259.4 (PPP, 2005 International) with a large standard deviation. The average HIV prevalence rate was about 6.2% but in one country it was 26.3%. On average, SSA had 4.9 children per woman (a proxy for household size), and female labour force participation averaged 62.7% of the economically active population. Average female literacy measured as primary school gross enrolment ratio in Sub-Saharan was at 92.1. However, Niger had very low female literacy rates at 26.5. The average ethnic fragmentation index (a proxy for social cohesion) was 0.63 (maximum possible index is 100). This indicates that ethnic fragmentation is high in Sub-Saharan Africa.

4.2 Econometric Results: Health Spending, Corruption and Under-Five Mortality Rates in Sub-Saharan Africa

This section presents the econometric results for the effects of health care spending and level of corruption on under-five mortality rates in Sub-Saharan Africa. The results are presented in sections 4.2.1 and 4.2.2 respectively. The estimation results of equations (3.8), (3.9) and (3.10) are presented in this section. In the remainder of this study, the interpretation of the results is based on linear dynamic panel GMM model estimates.

4.2.1 Total Health Expenditure, Corruption and Under-Five Mortality Rates

Table 5 shows the estimated effects of total health expenditure and corruption on under-five mortality rates. Model 1, is baseline model measuring the effects of total health expenditure on under-five mortality rates. Model 2, has an additional variable measuring the effect of corruption on under-five mortality rates. Model 3, determines the effectiveness of total health expenditure on under-five mortality rates with respect to change in corruption level. This is achieved by adding an interaction between level of corruption and health expenditure.

The diagnostic tests used for model 1 to 3 of the linear dynamic panel are the Wald criterion, Sargan test and Arellano-Bond autocorrelation test. Wald test in all the three models is significant at 1% rejecting the null hypothesis that there is no joint significance of the coefficients. The p-value for the Arellano-Bond test are large indicating that the null of no serial correlation in the first difference errors cannot be rejected. Sargan test for over-identification restriction validity show that the null hypothesis cannot be rejected. Thus instruments used in three GMM models are valid.

The estimated coefficient of total health spending in model 1 of Table 5, is negative and significant at 1% level. An increase in total health spending by 1% would reduce under-five mortality by about 0.14% annually in SSA. This result is consistent with that of Anyanwu and Erhijakpor (2007) and Farag, et al. (2013). But it differs from that of Gupta, et al. (1999) who found a positive but insignificant effect of total health expenditure on under-five mortality rates. However, these studies used different models from the one used in the study. The estimated coefficients of the control variables also show significant and correct signs in model 1. The exception is female literacy coefficient which is positive and significant. This may imply that as more female are getting educated they are likely to work away from home. Consequently, they delegate caring of their children to third party reducing the motherly attention (such as, providing emergency health care when children are ill unexpectedly) which is crucial for children under-five years.

Model 2 repeats the estimation but includes natural log of corruption index. The coefficient of total health spending is negative and significant but of smaller absolute magnitude. Increasing total health spending by 1% decreases under-five mortality rate by about 0.1%. The coefficient of natural log of corruption perception index is negative and significant. A 1% increase in the corruption index (increase implies lower levels of corruption) decreases under-five mortality by about 0.11%. The results are consistent with those of Yaqub, et al. (2012). In contrast, Hu and Mendoza (2013) and Rajkumar and Swaroop (2008) found positive and insignificant impact of corruption perception index on under-five mortality. Gupta, et al (2000) found a positive relationship between corruption (where 1; low corruption and 10; high corruption) and child mortality. The control variables still have expected signs and significantly influence under-five mortality rates. However, the sign of female literacy is still positive.

The estimation results under Model 3 include the interaction term between level of corruption and health expenditure. The estimated coefficient of total health expenditure, level of corruption and the interaction term are significant. The control variables exhibit the expected signs (except for female literacy) and are all significant (except for measles immunization rate) determinants of under-five mortality rates. Table 6 displays the derived estimates of effectiveness of total health expenditure on under-five mortality rates. The estimated coefficient of total health expenditure and that of the interactive variable were used to compute the effectiveness of total health expenditure evaluated at the minimum, maximum and mean values of the corruption perception index. Table 6 indicates that when level of corruption is perceived to be high (CPI =1), increasing total health spending by 1% reduce under-five mortality rate by about 0.42%. But when level of corruption is perceived to be low (CPI =6.4), 1% increase in total health spending decreases under-five mortality rates by about 0.32%. The lower effectiveness of total health expenditure on under-five mortality when corruption is perceived to be low than when it is perceived to be high could imply seekers of health service may be willing to participate in corruption to receive health care service (Gupta, et al., 2000). Subsequently, health sector personnel who control resources are likely to perpetuate corruption (Vian, 2008; Lewis, 2006b). If they are motivated to work better in a highly corrupt environment there is a likelihood of lower child mortality.

4.2.2 Public and Private Health Expenditure, Corruption and Under-Five Mortality Rates

Econometric results of the effect of public and private health spending and, corruption on under-five mortality rates are shown in Table 7. The results are displayed in three models. The baseline model (Model 4) includes public and private health expenditure and the set of control variables. Modell 5 extends model 4 by including corruption perception index to measure the effect of corruption on under-five mortality rates. Model 6 includes all variables in model 5 and adds interaction terms between corruption index and natural log (public health expenditure) and, between corruption index and natural log (private health expenditure). The aim is to determine the effectiveness of both public and private health expenditure on under-five mortality rates.

The p-value (0.00) for Wald test indicate that the null hypothesis of no joint significance in the coefficient estimates can be rejected. The Arellano-Bond test for autocorrelation shows that the null hypothesis of no serial correlation cannot be rejected as the p-values are more than 0.10. The p-value of Sargan test shows the over-identification restrictions are valid. Thus, the instruments used are valid.

The results for model 4 show that coefficient of public health expenditure is negative and significant while that of private health spending is positive and insignificant. Increasing public health expenditure by 1% decreases under-five mortality by about 0.24%. The insignificant private health expenditure coefficient may be due to crowding out effect because of the relatively strong effect of public health expenditure in reducing under-five mortality. The public health expenditure results are consistent with those of Novignon, et al. (2012) and Freire and Kajiura (2011). However, the two studies found that private health expenditure had a negative significant effect on under-five mortality rate. It is vital to note that the two studies have applied different models and estimation methods to the one used in this study. Except for female literacy the coefficients of control variables in model 4 are significant and have expected signs.

When the corruption perception index is included (Model 5) the coefficient of public health expenditure is still negative and has significant effect on under-five mortality while private health expenditure is insignificant. In this case an increase in public health spending by 1% leads to a reduction in under-five mortality by about 0.13%. These results imply that when we control for corruption the effect of public health expenditure on under-five mortality is smaller. The coefficient on level of corruption is negative and significant at 1% level. Increasing the CPI by 1% (lower level of corruption) reduced under-five mortality by about 0.51%. The results for effect of corruption on under-five mortality rates are consistent to those of Yaqub, et al. (2012). In contrast, Hu and Mendoza (2013) and Rajkumar and Swaroop (2008) found a positive and insignificant effects of corruption on under-five mortality rates. Gupta, et al. (2000) found that higher corruption levels had a positive effect on under-five mortality. The estimated coefficients of intervening variables have expected signs (except for female literacy) and are significant.

The results above indicate that public health expenditure is more relevant in reducing child mortality in SSA than private health expenditure. This maybe because most childhood health intervention are public funded. Most health services (such as immunizations; ART therapy for HIV expectant mothers and children infected; vitamin supplements as well as child growth monitoring) for children under-five years are provided free in public health entities in most of SSA countries.

The interaction variables between public and private health expenditure components and the corruption index (Model 6) are significant. The estimate of interaction between corruption index and public health expenditure is negative while that of corruption perception index and private health expenditure is positive. Similarly, Rajkumar and Swaroop (2008) found a negative coefficient for interaction between public health expenditure and corruption perception index. In contrast, both Hu and Mendoza (2013) and Yaqub, et al. (2012) found positive effect of interactions of public health expenditure and corruption index on under-five mortality but the former had insignificant estimates. The control variables estimates in the model exhibit expected signs (except for measles immunization and female literacy) and are significant.

The net effects of public and private health expenditure taking into account their interaction with the corruption perception index are derived and presented in Table 8. The net effect is evaluated at the mean, minimum and maximum levels of corruption. The estimates of public and private health expenditure and the interactive variables are obtained from Table 7.The estimates in Table 8 show that in high corruption scenario (CPI = 1) 1% increase in public health expenditure increases under-five mortality rate by 0.12% while private health spending reduced under-five mortality rate by about 0.26%. Increasing public spending on health care by 1% in a country with average level of corruption (CPI = 3) increases under-five mortality by about 0.02%. But raising private health spending by 1% reduces under-five mortality by about 0.14%. In low corruption environment (CPI = 6.4), an increase in public health spending by 1% leads to a fall in under-five mortality by about 0.16%. But increasing private health spending by 1% increased under-five mortality by about 0.08%.The results indicate that when corruption is perceived to be low (high CPI) the effectiveness of public health spending on under-five mortality increases. In contrast, when corruption is perceived as high (low CPI) private health expenditure effectiveness is high.

4.3 Regional Differences in the Impact of Health Care Spending and Corruption on Under-Five Mortality Rates

Equations (3.10), (3.11) and (3.12) estimations are presented in this section. Regional differences in the effect of health care spending (total, public and/or private) and level of corruption on under-five mortality rates results are presented in sections 4.3.1 and 4.3.2 based on GMM-IV linear dynamic panel estimates. The estimated results are shown in Tables 9, 10, 11 and 12.

4.3.1 Regional Based Total Health Expenditure, Corruption and Under-Five Mortality Rates

The regression results for the relationship between total health expenditure, corruption and under-five mortality are presented in Table 9. The econometric estimates are displayed in three models. To investigate whether the impact of total health expenditure and perceptions about corruption differs across regions within SSA, these variables were interacted with three dummy variables for Eastern Africa, Central Africa and Western Africa. Southern Africa dummy is omitted to avoid dummy variable trap. The estimation results of under-five mortality equation with interaction terms are reported in Table 9.

The Wald test p-value (0.00) indicates that the null hypothesis of no joint significance is rejected and the three GMM models are well fitted. The p-value for Arellano-Bond test shows that the null hypothesis of no serial correlation in the first difference errors cannot be rejected. The Sargan test cannot reject the null hypothesis of over-identification restrictions being valid as the p-value is large.

The parameter estimates of the variables of interest (health expenditure, corruption perception index and interaction terms) were used to derive the effectiveness of health expenditure on under-five mortality rate for the different SSA sub-regions. Table 18 shows estimates of the effectiveness of total health expenditure. The reference sub-region is Southern Africa. In the baseline model (model 7a) increasing total health expenditure by 1% reduced under-five mortality in Southern Africa by 0.36%, followed by Eastern Africa (0.24%), Central Africa (0.11%) and Western Africa (0.08%). So, total health expenditure reduces under-five mortality most effectively in Southern Africa. When effect of corruption level is taken into account (Model 8a) the magnitudes of the effectiveness of total health expenditure across the four regions change. For instance, effectiveness of total health expenditure in Western Africa and Central Africa is greater than the other two regions. On the other hand, effectiveness of Southern Africa and Eastern Africa total health expenditure is reduced when we control for corruption levels. Raising total health expenditure by 1% reduces under-five mortality by 0.87% and 0.33% for Western and Central Africa respectively.

Table 10 also shows that there are regional differences in effectiveness of reduced corruption levels on under-five mortality. In particular, lowering corruption levels in Southern Africa is more effective in reducing under-five mortality, than the other three regions. When corruption levels are dropped by 1% under-five mortality in Southern Africa is reduced by about 0.87%, 0.5% in Eastern Africa and 0.11% in Western Africa. In contrast in Central Africa, reduced level of corruption increases under-five mortality by 0.09%. Model 9a was used to investigate how perceived corruption levels affects the effect of total health expenditure on under-five mortality. Western Africa exhibits higher effectiveness of total health expenditure than the other three regions. At average corruption perception index (CPI = 3), increasing total health expenditure by 1% in Western Africa reduced under-five mortality by about 0.74% compared with 0.13% in Central Africa. But 1% increase in total health expenditure raise under-five mortality by 0.08% and 0.07% in Southern Africa and Eastern Africa respectively.

4.3.2 Regional Based Public and Private Health Expenditure, Corruption and Under-Five Mortality Rates

This section presents estimates of the effect of public and private components of health expenditures and perceived corruption levels on under-five mortality rates in SSA sub-regions. The results are presented in Table 11. The estimated equations are similar to those estimated in section 4.3.1 except health expenditure is disaggregated into public and private components. Wald test reject the null of no joint significance of the coefficient estimates because the p-value is 0 in the three GMM models. Arellano-Bond test fails to reject the null of no serial correlation in the models specified as the p-value is large. Additionally, the Sargan test null hypothesis of over-identification restriction are valid cannot be rejected because the estimate of p-value is large. This show that the instruments used in the GMM models are valid.

The econometric results in Table 11 are employed in Table 12 to derive effects of public and private health expenditure and corruption perception on under-five mortality rates in the SSA sub-regions. Table 12 corresponds to the models 10, 11 and 12 in Table 11. In Table 12, model 10a examines the baseline regional variations in public and private health spending effects on under-five mortality. The results indicate that Western Africa experiences high effectiveness in both public and private health spending in reducing under-five mortality compared to the other three regions. Increasing Western Africa public and private health spending by 1% reduce under-five mortality by about 0.14% and 0.73% respectively. While increasing public health expenditure reduces under-five mortality by 0.11% in Central Africa and private health expenditure increases it by 0.21%. Southern Africa and Eastern Africa show deteriorating under-five mortality when public health spending is increased. However, when private health expenditure is increased by 1% under-five mortality decreases by 0.34% and 0.20% in both regions respectively. The results reveal that on the extreme end, Eastern Africa and Southern Africa experience lower effectiveness of public health expenditure than that of their private health expenditure on under-five mortality. The strong effectiveness of private health expenditure substitutes the public health expenditure.

When corruption index is factored in model 11a, effectiveness of public health spending in Southern Africa is higher relative to the other three regions. Increase in public health spending in Southern Africa by 1% reduces under-five mortality by about 0.15%. This is followed by Eastern Africa (0.09%) and Central Africa (0.04%) respectively. Private health spending effectiveness is greater in Eastern Africa relative to that of Southern, Western and Central Africa respectively. Increasing Eastern and Southern Africa private health spending by 1% reduces under-five mortality by about 0.23% and 0.19%. By controlling for corruption in model 11a, the Western Africa public and private health expenditure effects on under-five mortality deteriorates. Eastern Africa and Southern Africa public and private health expenditure turned out to be complementary rather than substitutes as in model 10a. Central Africa maintains the relationship as in model 10a where its public health expenditure is stronger than private health expenditure in reducing under-five mortality.

Improvement in quality of governance by lowering corruption is vital for efforts to reduce under-five mortality in the SSA sub-regions. Reduced corruption in Eastern Africa is stronger relative to other regions. A reduction in the level of corruption in Eastern Africa by 1% reduces under-five mortality by about 0.41%. This is followed by Southern Africa and Western Africa while effect of corruption on under-five mortality is positive in Central Africa. In model 12a, increase in public health expenditure at the average corruption perception index (CPI = 3) reduce under-five mortality in Southern and Eastern Africa more than in Western and Central Africa. Considering the average level of corruption in the Southern and Eastern Africa, a rise in public health expenditure by 1% reduces under-five mortality by 0.07% and 0.06% respectively. Southern Africa also has the most effective private health expenditure at the average corruption perception index than the other three regions. Increasing private health expenditure by 1% reduces under-five mortality in Southern Africa by 0.08%. From the results discussed the effectiveness of public health spending and private health expenditure are still complementary in Southern Africa but substitutable in Eastern Africa. In Western Africa and Central Africa, if both public and private health expenditure are dependent on levels of corruption, the under-five mortality are high in both sectors.

5. Conclusions

This paper investigated the effects of health expenditure on child mortality and how governance (measured as corruption perception index) affects the relationship in SSA for the period 2000-2009. Although child mortality in SSA has been declining, under-five mortality are higher than the other regions of the world. This study argued that policy measures to reduce child mortality in SSA are increasing health expenditure and reducing levels of corruption. Though there have been efforts to increase health expenditure through initiatives such as Abuja Declaration the pace of its implementation is still slow in most of the countries ten years on (Tandon and Cashin, 2010). Meanwhile, the incidence of corruption in all sectors of the economy is still a big challenge and this may have adverse effect on effectiveness of resources allocated to the health sector (Lewis, 2006a; 2006b.The main purpose of this paper was to determine the effects of health expenditure and to assess the impact of governance on effectiveness of health expenditure on under-five mortality in the post Abuja Declaration period.

The study used panel data for 41 countries and employed linear dynamic panel data model. (LDPD). This model is a hybrid of the dynamic panel data methods developed by Arellano and Bond (1991), Arellano and Bouver (1995), and Blundell and Bond (1998). The LDPD is the preferred model because it controls for endogeneity of health expenditure, allows for dynamics, unobserved heterogeneity and embodies stationarity restrictions. The study contributes to a small but potential expanding empirical literature on the role of governance environment plays in the relationship between health expenditure and child mortality. There is dearth of studies focusing on SSA and taking into account dynamics within panel data settings.

The empirical results suggest that total health expenditure reduces under-five mortality in SSA. The results also show that when public health expenditure is stronger in reducing under-five mortality it crowds out the relative effects of private health expenditure. Lowering corruption is essential in achieving low under-five mortality rates.

Further, the results suggest that effectiveness of health expenditure on under-five mortality differs across SSA region. Southern Africa and Eastern Africa total health expenditure is more effective in reduction of under-five mortality than the other three regions. But when effect of corruption is controlled for total health expenditure has greater effectiveness in reducing under-five mortality rates in Western Africa and Central Africa. Southern Africa and Eastern Africa exhibit lower under-five mortality when corruption is reduced relative to other regions. Increasing total health expenditure when corruption levels are average, Western Africa region experienced high reduction in under-five mortality than the other three regions.

The study also found that regional differences in the effect of public and private health expenditure on under-five mortality rate. Public and private health expenditure in Western Africa were more effective in reducing under-five mortality more than the other three regions. When corruption was controlled for, Southern Africa had the strongest public health expenditure while Eastern Africa had the strongest private health expenditure among the four regions. Reducing levels of corruption in both Southern Africa and Eastern Africa reduced under-five mortality rate more than Central and Western Africa. Increasing public and private health expenditure at average levels of corruption reduced under-five mortality in Southern Africa more than the other three regions.

In conclusion adequate health expenditure is important for the reduction of under-five mortality rates in Sub-Saharan Africa. Additionally, reducing corruption leads to better child health and high effectiveness in health expenditure geared toward health care. There exist regional differences on the effects of health expenditure and corruption on child health across the four regions; Eastern Africa, Western Africa, Southern Africa and Central Africa. Effectiveness of health expenditure relative to corruption also differs across the regions.

The policy implications arising from the study are as follows. First, it reveals to policy makers the importance of allocating more resources to health care. Second, it provides a strong argument for commitments in the implementation of Abuja Declaration on public health expenditure targets by Sub-Saharan Africa governments. The issue of health expenditure effectiveness with regard to corruption is important to policy makers. Mitigating against corruption is likely to increase effectiveness of health expenditure, which would improve child health as result of efficient delivery of health service. Because private health expenditure is more effective in high corruption levels, anti-corruption measures may lead public health workers (those who moved their services to private sector) to transfer their services back to public health service. This is because health care seekers are likely to shift demand for health services towards public health sector because of increased effectiveness in service delivery.

Understanding the regional differences in the effectiveness of health expenditure on child health is also relevant to policy makers. Coordinated efforts such as anti-corruption measures, provides a suitable environment for full implementation and assures success of joint health policies in SSA (AU's Abuja Declaration on public health expenditure and the Ouagadougou Framework on primary health). The success of the joint policies between governments and regional affiliations may promote integration and support to countries with weak health outcomes, such as high child mortality.

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Table 1: Regional Comparison of Under-Five Mortality Rates across World Regions

Region	Under-Five Mortality rates (Deaths per 1000 live births)			MDG Target	Decline in Under-Five Mortality Rates (%)		
	1990	2000	2011	2015	1990-2011	1990-2000	2000-2011
Africa	163	141	**100**	**54**	39	13	29
Sub-Saharan Africa	178	154	**109**	**59**	39	13	29
Eastern and Southern Africa	162	135	**84**	**54**	48	17	38
West and Central Africa	197	175	**132**	**66**	33	11	25
Middle East and North Africa	72	52	**36**	**24**	50	28	31
Asia	85	65	**44**	**28**	49	24	32
South Asia	119	89	**62**	**40**	48	25	30
East Asia and Pacific	55	39	**20**	**18**	63	29	49
Latin America and Caribbean	53	34	**19**	**18**	64	36	44
Central and Eastern Europe/Commonwealth of Independent States	48	35	**21**	**16**	56	27	40
World	87	73	**51**	**29**	41	16	30

Source of Data: UN Inter-Agency (UNICEF, WHO, World Bank, UNPD and UN DESA) Child Mortality Estimation (2012).

Table 2: Probable Factors Influencing the Decline in Under-Five Mortality Rates in SSA

Percentage of Children Under-five Years Using Insecticide Treated Bed Nets (ITNs)	3% (2000); 23% (2006); 24% (2008); 35% (2009); 50% (2011); 53% (2012). Results: Malaria specific mortality rates decreased by about 33% in SSA in the period 2000-2010 (World Health Organization, 2011b).
Immunization Rates for Measles (%) of 12-23 months children)	53% (2000); 69% (2008); 74% (2010); *73*% (2012). Results: The number of deaths averted from measles increased from 197,900 in 2000 to 569,300 in 2010 (Simons, et al., 2012)
Pregnant Women with HIV Receiving Anti-Retroviral Therapy to Prevent Mother to Child Transmission (MTCT)	446,000(34%) in 2007; 576, 800 (45%) in 2008; 672,900 (54%) in 2009; 674,000 (50%) in 2010. Results: Number of new pediatrics cases of HIV infections reduced from 430,000 in 2009 to 390,000 in 2010 (WHO, et al., 2011).
Average Real Gross Domestic Product Growth (Annual %)	6.4% (2004-2008); 5.4% (2010); 5.3% (2011); 5.1% (2012). (World Bank, 2013)
Female Literacy (% Gross enrolment rate for Primary Education)	74.8% (2000); 79.7% (2002); 85.6% (2004); 91.5 % (2006); 94.8% (2008); 95.8% (2010). (World Bank, 2013)
Average Increase in Public Health Spending as % of Government Expenditure	0.9% (2000); 8.5% (2002); 9.2% (2004); 9.6% (2006); 9.4% (2008); 9.8% (2011); (World Bank, 2013)
Women Empowerment (proxy for ability to earn income) - (Labor Force Participation Rates %)	61.3 (2000); 62.7% (2006) ; 63.1 (2011) (World Bank, 2013)
Governance (CPIA Quality of Public Administration Rating; low=1; high=6)	Average of 2.9 (for the period 2005-2011) (World Bank, 2013)
Governance; (CPIA Transparency, Accountability and Corruption in Public Sector rating; low=1; high=6).	Average of 2.8 (for the period 2005-2011) (World Bank, 2013)
Poverty Reduction (those living under 1.25/day % of population	55.7% (2002); 52.3% (2005); 49.2% (2008); 48.5% (2010). (World Bank, 2013)

Sources of Data: Several World Malaria Reports (2008-2012); Global HIV/AIDS Response Reports (2006-2011); World Development Indicators (World Bank, 2013); WHO (Global Health Observatory, 2013).

Table 3: Data Sources and Definition of Variables

Variable Name	Description	Data Source
Under-five mortality rate	Under-five mortality rate is the probability per 1,000 live births that a new-born baby will die before reaching age five, if subject to current age-specific mortality rates. This variable in specified in natural logarithm form.	World Development Indicators (World Bank, 2011)
Public Health Expenditure	Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds. Measured as the total public health expenditure. Measured in US$ millions.	World Development Indicators (World Bank,2011); WHO National Health Accounts, 2013
Private Health Expenditure	Private health expenditure includes direct household (out-of-pocket) spending, private insurance, charitable donations, and direct service payments by private corporations. Measured as total private health expenditure. Measured in US$ millions	World Development Indicators (World Bank,2011) ;WHO National Health Accounts (2013)
Total Health Expenditure	Total health expenditure is the sum of public and private health expenditures. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Measured in US$ millions.	World Development Indicators (World Bank,2011); WHO National Health Accounts (2013)
Real GDP per Capita	GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international US$ using purchasing power parity rates. Data are in constant 2005.	World Development Indicators (World Bank, 2011)
HIV Prevalence Rate	Prevalence of HIV refers to the percentage of people aged 15-49 that are infected with HIV.	World Development Indicators (World Bank, 2011)
Total Fertility Rate	Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. (proxy for household size)	World Development Indicators (World Bank, 2011)
Measles immunization rates	Child immunization measures the percentage of children aged 12-23 months who received vaccinations before 12 months or at any time before the survey. A child is considered adequately immunized against measles after receiving one dose of vaccine.	World Development Indicators (World Bank, 2011)
Ethnic Fragmentation	Reflects probability that two randomly selected people from a given country will not belong to the same ethno linguistic group. The higher the number, the more fractionalized is the society. The definition of ethnicity involves a combination of racial and linguistic characteristics. It's a proxy for social capital	University of Gothenburg (Quality of Governance Institute).(2011)
Transparency International-Corruption Perception Index	The CPI focuses on corruption in the public sector and defines corruption as the abuse of public office for private gain. The surveys used in compiling the CPI tend to ask questions in line with the misuse of public power for private benefit, with a focus, for example, on bribe-taking by public officials in public procurement. The sources do not distinguish between administrative and political corruption. The CPI Score relates to perceptions of the degree of corruption as seen by business people, risk analysts and the general public and ranges between 10 (highly clean) and 0 (highly corrupt).	University of Gothenburg (Quality of Governance Institute) (2011)
Female Literacy	Female gross enrolment ratio is the ratio of total enrolment for primary education, regardless of age, to the population of the aged group that officially corresponds to the level of education shown. This is a basic measure for literacy as ability to read, write and speak. A proxy for female literacy.	World Development Indicators (World Bank, 2011)
Female Labour Force Participation Rate (FELP)	Female labour force as a percentage of the total shows the extent to which women are active in the labour force. Labour force comprises people of ages 15 and older who meet the International Labour Organization's definition of the economically active population.	World Development Indicators (World Bank, 2011)

Table 4: Descriptive Statistics for Various Indicators in Sub-Saharan Africa over the Period 2001-2009

Variable	Obs	Mean	Std. Dev	Min	Max
Under-five mortality rate (UMR) per 1000 live births	410	114.9	43.6	13.5	217.8
Public Health Expenditure (Million US$ Constant 2000)	410	759	2,160	4.98	15,700
Private Health Expenditure (Million Constant 2000 US$)	410	1,130	3,490	7.4	23,500
Total Health Expenditure (Million US $, Constant, 2005)	410	1890	5,620	14.1	39,200
Real GDP per Capita (Constant. 2005 , PPP US$)	409	3259.4	4998.2	346.1	31738.2
HIV Prevalence Rate (%)	370	6.2	7.1	0.1	26.3
Measles immunization rates (%)	410	71.6	17.6	17	99
Total Fertility Rate (No of Children per Woman)	410	4.87	1.21	1.5	7.5
Ethnic Fragmentation	410	0.63	0.23	0.01	0.93
Transparency International-Corruption Perception Index	276	3.02	1.06	1	6.4
Female Literacy	410	92.1	27.3	26.5	152.5
Female Labor Force Participation Rate (%)	400	62.7	16.0	28.9	91

Table 5: Effects of Total Health Expenditure and Corruption on Under-Five Mortality Rates (Dependent Variable is the ln (Under-Five Mortality Rates))

Independent Variables	**Model 1**			**Model 2**			**Model 3**		
	FE	RE	LDPD	FE	RE	LDPD	FE	RE	LDPD
ln(Total health expenditure)	**-0.111** (-4.17)	**-0.069** (-3.48)	**-0.136** (-4.96)	**-0.006** (-0.18)	**-0.085** (-3.72)	**-0.102** (-5.23)	**-0.018** (-0.54)	**-0.097** (-4.18)	**-0.433** (-4.35)
ln(Real Gross Domestic Product per Capita)	**-0.104** (-2.21)	**-0.120** (-3.37)	**-0.275** (-7.07)	**-0.632** (-7.30)	**-0.234** (-4.30)	**-0.300** (-8.57)	**-0.615** (-7.08)	**-0.227** (-4.23)	**-0.136** (-1.88)
ln(Female literacy)	**-0.003** (-0.07)	**0.016** (0.46)	**1.046** (4.82)	**0.056** (1.22)	**0.031** (0.67)	**0.819** (5.24)	**0.046** (1.00)	**0.021** (0.45)	**0.729** (3.80)
Female labour force participation rate	**-0.014** (-2.14)	**-0.004** (-1.56)	**-0.015** (-5.00)	**-0.016** (-1.87)	**-0.009** (-3.06)	**-0.016** (-6.44)	**-0.016** (-1.89)	**-0.008** (-2.93)	**-0.018** (-6.36)
Total fertility rate	**0.171** (4.55)	**0.248** (10.18)	**0.362** (20.63)	**0.213** (4.25)	**0.289** (8.77)	**0.287** (24.37)	**0.212** (4.24)	**0.292** (8.98)	**0.274** (14.73)
HIV prevalence rate	**0.043** (6.51)	**0.029** (6.61)	**0.063** (6.67)	**0.074** (10.48)	**0.047** (9.45)	**0.069** (8.16)	**0.072** (10.17)	**0.045** (8.95)	**0.071** (7.98)
Measles immunization rate	**0.0003** (0.45)	**-0.0003** (-0.51)	**-0.009** (-13.04)	**0.0003** (0.35)	**-0.0003** (-0.45)	**-0.010** (-16.47)	**0.0003** (0.41)	**-0.0003** (-0.37)	**-0.0003** (-0.09)
ln(Ethnic fragmentation)	-	**0.093** (1.80)	**0.189** (4.82)	-	**0.127** (2.20)	**0.190** (5.51)	-	**0.123** (2.17)	**1.473** (3.55)
ln(Corruption Index)	-	-	-	**-0.034** (-0.97)	**-0.081** (-2.20)	**-0.113** (-2.22)	**-0.185** (-1.82)	**-0.310** (-2.81)	**-1.197** (-2.20)
Corruption Index * ln (Total health expenditure)	-	-	.-	-	-	-	**0.003** (1.59)	**0.004** (2.20)	**0.017** (2.27)
Constant	**7.438** (9.32)	**5.377** (10.97)	**3.458** (14.12)	**8.732** (7.74)	**6.452** (9.69)	**4.426** (14.84)	**8.889** (7.88)	**6.640** (10.00)	**4.694** (5.63)
Number of Observations	370	370	370	255	255	255	255	255	255
F-Test, (p-value)	71.49 (0.00)	-	-	90.55 (0.00)	-	-	81.34 (0.00)	-	-
R-Squared	60.55		-	77.36	73.98	-	77.63	74.33	-
Wald Test χ^2, (p-value)	-	535.3 (0.00)	11764.9 (0.00)		582.9	15583.2 (0.00)		594.3 (0.00)	16290.9 (0.00)
Hausman test χ^2, (p-value)	21.95 (0.00)		-	39.46 (0.00)			34.36 (0.00)		
Sargan Test χ^2, (p-value)			10.499 (0.94)			21.129 (0.33)			12.086 (0.74)
Arellano-Bond Autocorrelation test (AR) z-value (p=value)			1.202 (0.23)			-0.266 (0.79)			0.581 (0.56)
Number of Instrumental Variables			28			29			27

Notes: (1) FE- Fixed Effects Model; RE- Random Effects Model; LDPD- Linear Dynamic Panel Data Model; (2) t-values are for the FE Estimation, and z-values are for the RE and LDPD estimations are shown in the parentheses; (3) Where p= are the probability values; (4) Instruments: Model 1 (four years lagged ln (under-five mortality rate) (GMM), differences of total fertility rate, ln (real income per capita), female labour participation rate, measles immunization rate and ln (ethnic fragmentation); levels, total fertility rates, ln (real income per capita), female labour force participation rate, measles immunization rate, ln (ethnic fragmentation) and ln (total health expenditure): Model 2 (four period lagged ln (under-five mortality rate) (GMM), differences of log (corruption index), total fertility rate, ln (real income per capita), female labour force participation rate, measles immunization rate, ln (ethnic fragmentation) and the ln (total health expenditure): levels, total fertility rate, ln (real income per capita), female labour force participation rate, measles immunization rate, ln (ethnic fragmentation) and the ln (total health expenditure): Model 3 (four period lagged ln (under-five mortality rate) (GMM); differences of ln (real income per capita) and female labour force participation: levels, levels, ln (real income per capita), female labour force participation rate, total fertility rate, ln (total health expenditure) and the measles immunization rate.

Table 6: Effectiveness of Total Health Expenditure on Under-Five Mortality Rates in Sub-Saharan Africa Based on Estimates of Linear Dynamic Panel Model

Corruption Perception Index	Mean	Min	Max
	3	**1**	**6.4**
Coefficient of ln (Total health expenditure)	-0.433	-0.433	-0.433
Coefficient of corruption Index*ln(total health expenditure)	0.051	0.017	0.109
Net Effect	**-0.382**	**-0.416**	**-0.324**

Calculations based on estimates in Model 3 of Table 5.

Table 7: Effects of Public and Private Health Expenditure and Corruption on Under-Five Mortality (Dependent Variable is the ln (Under-Five Mortality Rates))

Independent Variables	Model 4			Model 5			Model 6		
	FE	RE	LDPD	FE	RE	LDPD	FE	RE	LDPD
ln(Public health expenditure)	**-0.073** (-3.72)	**-0.063** (-3.49)	**-0.238** (-3.65)	**-0.056** (-2.68)	**-0.105** (-5.41)	**-0.128** (-2.64)	**-0.073** (-1.88)	**0.023** (0.58)	**0.174** (1.99)
ln(Private health expenditure)	**-0.028** (-1.15)	**0.002** (0.10)	**0.076** (1.54)	**0.067** (2.73)	**0.021** (1.04)	**0.018** (0.43)	**-0.093** (-2.08)	**-0.131** (-2.97)	**-0.328** (-3.35)
ln(Real Gross Domestic Product per Capita)	**-0.112** (-2.37)	**-0.117** (-3.26)	**-0.222** (-6.12)	**-0.611** (-7.24)	**-0.223** (-4.10)	**-0.222** (-7.29)	**-0.643** (-7.81)	**-0.258** (-4.78)	**-0.442** (-3.45)
ln(Female literacy)	**0.007** (0.18)	**0.024** (0.70)	**1.109** (4.63)	**0.093** (2.04)	**0.061** (1.36)	**0.643** (4.15)	**0.127** (2.80)	**0.095** (2.10)	**0.170** (1.97)
Female labour force participation rate	**-0.013** (-1.99)	**-0.003** (-1.46)	**-0.015** (-4.67)	**-0.010** (-1.21)	**-0.009** (-2.90)	**-0.012** (-5.47)	**-0.013** (-1.59)	**-0.009** (-3.13)	**-0.030** (-2.26)
Total fertility rate	**0.182** (4.78)	**0.256** (10.47)	**0.386** (16.03)	**0.259** (5.26)	**0.306** (9.40)	**0.265** (22.08)	**0.229** (4.78)	**0.289** (8.99)	**0.278** (3.45)
HIV prevalence rate	**0.045** (6.72)	**0.030** (6.80)	**0.061** (6.21)	**0.073** (10.80)	**0.049** (9.94)	**0.072** (8.18)	**0.066** (9.71)	**0.046** (9.35)	**0.081** (5.22)
Measles immunization rate	**0.0004** (0.69)	**-0.0001** (-0.21)	**-0.007** (-10.94)	**0.0006** (0.86)	**0.0003** (0.42)	**-0.006** (-14.22)	**0.0004** (0.61)	**0.0002** (0.24)	**0.002** (1.90)
ln(ethnic fragmentation)	-	**0.081** (1.57)	**0.185** (4.51)	-	**0.115** (1.95)	**0.187** (5.17)	-	**0.123** (2.11)	**0.285** (2.74)
ln(corruption index)	-	-	-	**-0.039** (-1.16)	**-0.085** (-2.39)	**-0.514** (-9.86)	**-0.230** (-2.51)	**-0.361** (-3.48)	**-0.933** (-4.84)
Corruption index* ln(public health expenditure)	-	-	-	-	-	-	**-0.044** (-3.90)	**-0.043** (-3.54)	**-0.052** (-2.28)
Corruption index*ln(private health expenditure)	-	-	-	-	-	-	**0.048** (4.15)	**0.048** (3.88)	**0.064** (2.72)
Constant	**7.043** (8.38)	**5.084** (10.16)	**2.914** (7.34)	**7.471** (6.61)	**6.036** (8.98)	**4.775** (11.78)	**8.562** (7.67)	**6.720** (9.96)	**9.132** (4.82)
Number of Observations	370	370	370	255	255	255	255	255	255
F-Test, (p-value)	62.06 (0.00)	-	-	88.35 (0.00)	-		79.78 (0.00)		-
R-Squared	60.44	59.30	-	79.03	75.96		80.77	78.14	-
Wald Test χ^2, (p-value)	-	539.1 (0.00)	10490.4 (0.00)		642.76	15499.6 (0.00)		712.62 (0.00)	3075.84 (0.00)
Hausman test χ^2, (p-value)	38.93 (0.00)			37.93 (0.00)			37.84 (0.00)		
Sargan Test χ^2, (p-value)			9.696 (0.96)			25.794 (0.14))			42.292 (0.63)
Arellano-Bond Autocorrelation test (AR) z-value (p=value)			1.275 (0.20)			-0.108 (0.91)			1.452 (0.15)
Number of Instrumental Variables			29			30			59

.Notes: 1) FE- Fixed Effects Model; RE- Random Effects Model; LDPD- Linear Dynamic Panel Data Model. 2) t-values are for the FE Estimation, and z-values are for the RE and LDPD estimations are shown in the parentheses. 3) Where p= are the probability values. 4) Instruments: Model 4 (four period lagged ln (under-five mortality rates) (GMM), ln (private health expenditure), total fertility rates, ln (real GDP per capita), female labour participation, measles immunization rates and the ln (ethnic fragmentation): levels, total fertility rates, ln (real income per capita), female labour force participation, measles immunization rate, ln (ethnic fragmentation) and the ln (public health expenditure): Model 5 (four period lagged ln (under-five mortality rates) (GMM), ln (private health expenditure), total fertility rate, ln (real GDP per capita), female labour force participation, measles immunization rates, ln (ethnic fragmentation) and the ln (corruption index): levels, total fertility rate, ln (real GDP per capita), female labour force participation, measles immunization rates, ln (corruption index) and the ln (public health expenditure: Model 6 (four period lagged ln (under-five mortality rate) (GMM) and two period lagged interaction of corruption index and ln (public health expenditure)(ethnic fragmentation): levels, ln (ethnic fragmentation).

Table 8: Effectiveness of Public and Private Health Expenditure on Under-Five Mortality Rates in Sub-Saharan Africa Based on Estimates of Linear Dynamic Panel Model

Corruption Perception Index (CPI)	Mean (3)	Min (1)	Max (6.4)
A. Effectiveness of Public Health Expenditure			
ln (public health expenditure)	0.174	0.174	0.174
Corruption index*ln (public health expenditure)	-0.156	-0.052	-0.332
Net Effect	**0.018**	**0.122**	**-0.158**
B. Effectiveness of Private Health Expenditure			
ln (private health expenditure)	-0.328	-0.328	-0.328
Corruption index*ln(private health expenditure	0.192	0.064	0.410
Net Effect	**-0.136**	**-0.264**	**0.082**

Calculations based on estimates in Model 6 of Table 7.

Table 9: Regional Differences of Total Health Expenditure and Corruption Influence on Under-Five Mortality (Dependent Variable is ln (Under-Five Mortality Rates))

Independent Variables	Model 7			Model 8			Model 9		
	FE	RE	LDPD	FE	RE	LDPD	FE	RE	LDPD
ln(Total health expenditure)	**-0.181** (-5.68)	**-0.08** (-3.72)	**-0.356** (-4.74)	**-0.101** (-2.52)	**-0.107** (-4.30)	**-0.092** (-3.12)	**-0.098** (-2.45)	**-0.109** (-4.40)	**0.075** (2.62)
ln(Real Gross Domestic Product per Capita)	**-0.08** (-1.72)	**-0.166** (-4.31)	**-0.268** (-3.08)	**-0.590** (-6.53)	**-0.254** (-4.73)	**-0.578** (-7.93)	**-0.583** (-2.45)	**-0.252** (-4.70)	**-0.589** (-8.25)
ln(Female literacy)	**0.012** (0.33)	**0.020** (0.59)	**0.482** (1.91)	**0.107** (2.35)	**0.059** (1.29)	**-0.091** (-0.75)	**0.095** (2.09)	**0.048** (1.05)	**-0.120** (-1.05)
Female labour force participation rate	**-0.018** (-2.85)	**-0.004** (-1.86)	**-0.009** (-1.77)	**-0.021** (-2.32)	**-0.008** (-3.20)	**-0.003** (-0.83)	**-0.020** (-2.26)	**-0.008** (-3.10)	**-0.003** (-0.66)
Total fertility rate	**0.140** (3.75)	**0.235** (9.87)	**0.176** (2.73)	**0.147** (2.90)	**0.252** (8.36)	**-0.062** (-1.48)	**0.151** (2.99)	**0.252** (8.37)	**-0.056** (-1.31)
HIV prevalence rate	**0.037** (5.51)	**0.033** (7.32)	**0.077** (10.25)	**0.067** (9.34)	**0.049** (10.40)	**0.045** (7.96)	**0.067** (9.26)	**0.049** (10.41)	**0.046** (8.18)
Measles immunization rate	**0.0003** (0.43)	**-0.0001** (-0.16)	**0.002** (0.94)	**-0.0004** (-0.64)	**-0.001** (-1.54)	**-0.008** (-3.98)	**-0.0004** (-0.66)	**-0.001** (-1.56)	**-0.007** (-3.61)
ln(Ethnic fragmentation)	-	**0.052** (1.02)	**0.973** (4.85)	-	**0.082** (1.65)	**-0.023** (-0.22)	-	**0.082** (1.64)	**-0.021** (-0.20)
Eastern African Dummy	**-0.160** (-3.48)	**-0.121** (-2.63)	**-0.202** (-2.32)	**-0.165** (-3.04)	**-0.169** (-2.91)	**-0.258** (-1.36)	**-0.167** (-3.37)	**-0.155** (-2.96)	**-0.189** (-1.11)
Central African Dummy	-	**-1.563** (-2.04)	**-4.390** (-1.94)	-	**-1.826** (-1.57)	**4.574** (1.78)	-	**-1.722** (-1.54)	**4.995** (2.05)
Western African Dummy	-	**0.382** (2.77)	**0.705** (1.88)	-	**0.034** (0.20)	**0.933** (1.37)	-	**0.0001** (0.00)	**1.046** (1.37)
Eastern African Dummy* ln(Total health expenditure)	**0.103** (3.84)	**0.077** (2.91)	**0.116** (2.62)	**0.102** (3.55)	**0.064** (2.10)	**-0.027** (-0.37)	**0.095** (3.25)	**0.054** (1.74)	**-0.023** (-0.32)
Western African Dummy* ln(Total health expenditure)	**-0.0001** (-0.00)	**-0.066** (-1.12)	**0.281** (3.91)	**0.032** (0.44)	**0.061** (0.81)	**-0.775** (-2.91)	**0.022** (0.30)	**0.097** (1.77)	**-0.855** (-3.13)
Central African Dummy* ln(Total health expenditure)	**0.133** (3.28)	**0.100** (2.65)	**0.248** (2.17)	**0.124** (2.01)	**0.106** (1.88)	**-0.235** (-1.92)	**0.108** (1.80)	**0.054** (0.72)	**-0.264** (-2.29)
ln(Corruption index)	-	-	-	**-0.099** (-1.98)	**-0.172** (-3.12)	**-0.870** (-5.75)	**-0.098** (-2.04)	**-0.174** (-3.37)	**-0.815** (-5.59)
Eastern African Dummy* ln(Corruption Index)	-	-	-	**0.008** (0.22)	**0.071** (1.75)	**0.369** (2.20)	-	-	-
Western African Dummy* ln(Corruption Index)	-	-	-	**0.192** (2.79)	**0.199** (2.56)	**0.756** (2.87)	-	-	-
Central African Dummy* ln(Corruption Index)	-	-	-	**0.220** (1.69)	**0.268** (1.87)	**0.958** (3.52)	-	-	-
Eastern African Dummy*Corruption Index *ln(Total health expenditure)	-	-	-	-	-	-	**0.0003** (0.67)	**0.001** (2.30)	**0.005** (2.28)
Western African Dummy*Corruption Index*ln(Total health expenditure)	-	-	-	-	-	-	**0.004** (2.74)	**0.004** (2.72)	**0.014** (2.42)
Central African Dummy*Corruption Index*ln(Total health expenditure)	-	-	-	-	-	-	**0.005** (1.61)	**0.006** (1.93)	**0.021** (3.11)
Constant	**8.720** (10.62)	**6.058** (12.02)	**6.522** (7.59)	**10.453** (9.01)	**7.161** (11.66)	**9.051** (12.89)	**10.377** (8.93)	**7.238** (11.80)	**9.346** (12.76)
Number of Observations	362	362	362	251	251	251	251	251	251
F-Test, (p-value)	51.71 (0.00)	-	-	55.16 (0.00)	-	-	54.97 (0.00)	-	-
R-Squared	64.4	62.8	-	80.5	78.01	-	80.4	78.1	-
Wald Test χ^2, (p-value)	-	611.63 (0.00)	44794 (0.00)	-	693.23 (0.00)	11,707.3 (0.00)	-	706.46 (0.00)	12178.3 (0.00)
Hausman test χ^2, (p-value)	36.61 (0.00)		-	93.85 (0.00)		-	47.51 (0.00)		-
Sargan Test χ^2, (p-value)	-	-	23.22 (0.33)	-	-	40.83 (0.27)	-	-	43.62 (0.18)
Arellano-Bond Autocorrelation test (AR) z-value (p=value)			1.563 (0.12)			-0.347 (0.73)			-0.580 (0.56)
Number of Instrumental Variables			36			55			55

Notes: (1) FE- Fixed Effects Model; RE- Random Effects Model; LDPD- Linear Dynamic Panel Data Model; (2) t-values for FE Estimation, and z-values for RE and LDPD estimations are in parentheses; (3) Where p= are the probability value; (4) Instruments:

Model 7 (three period lagged ln (real GDP per capita) (GMM), Western Africa dummy* ln (total health expenditure), total fertility rates, ln (under-five mortality rate), ln (total health expenditure), measles immunization rates, and HIV prevalence rate: levels, measles immunization rate, HIV prevalence rate and female labour force participation). Model 8 (two period lagged ln (real GDP per capita) (GMM), HIV prevalence rate, ln (under-five mortality rate), Western Africa dummy* ln (total health expenditure) and Central Africa dummy* ln (total health expenditure): levels, two period lagged differenced ln (total health expenditure) (GMM) and four period lagged difference ln (corruption index) (GMM), ln (under-five mortality rates), Western Africa dummy* ln (total health expenditure), Central Africa dummy*ln (total health expenditure), Western Africa* ln (corruption index) and ln (female literacy)). Model 9 (two period lagged ln (real GDP per capita) (GMM), HIV prevalence rate, ln (under-five mortality rate), Western Africa dummy*ln (total health expenditure), Central Africa*ln (total health expenditure) and the ln (female literacy): levels, two period lagged differenced ln (total health expenditure) (GMM), four period lagged ln (corruption index) (GMM), ln (under-five mortality rate), Western Africa dummy* ln (total health expenditure), Central Africa dummy* ln (total health expenditure), ln (female literacy), Western Africa dummy* ln (corruption index)).

Table 10: Regional Differences of Total Health Expenditure and Corruption Effects on Under-Five Mortality Rates

Dummy variables for the Region takes the value of 1; 0 otherwise. Computation Based on LDPD Estimates			
Model 7a: Regional Variations of Total Health Care Spending			
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.356	-0.240	-0.075	-0.108
Model 8a: Regional Variations of Total Health Care Spending and Corruption			
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.092	-0.350	-0.867	-0.327
-0.870	-0.501	-0.114	0.088
Model 9a: Regional Variations of Total Health Spending Efficacy (Interaction -Regional Dummy* Total Health Expenditure* Corruption); Computed using CPI Values at the mean			
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
0.075	0.067	-0.738	-0.126

Note: (1) The computation are based on estimates in Table 17 and they correspond to models 7, 8 and 9; (2) Mean values of CPI are extracted from the descriptive statistics..

Table 11: Regional Differences in Public and Private Health Expenditure, and Corruption Effects on Under-Five Mortality Rates (Dependent Variable is ln (Under-Five Mortality Rates))

Independent Variables	**Model 10**			**Model 11**			**Model 12**		
	FE	RE	LDPD	FE	RE	LDPD	FE	RE	LDPD
ln (public health expenditure)	**-0.111** (-4.29)	**-0.104** (-4.20)	**0.585** (4.92)	**-0.153** (-5.78)	**-0.190** (-7.26)	**-0.151** (-3.28)	**-0.148** (-5.47)	**-0.187** (-7.33)	**-0.077** (-2.40)
ln (Private health expenditure)	**-0.003** (-0.09)	**0.035** (1.27)	**-0.202** (-2.23)	**0.115** (3.72)	**0.065** (2.52)	**-0.190** (-4.31)	**0.085** (2.82)	**0.063** (2.42)	**-0.081** (-2.07)
ln (Real Gross Domestic Product per Capita)	**-0.176** (-3.60)	**-0.190** (-4.88)	**-0.076** (-0.89)	**-0.516** (-6.14)	**-0.208** (-3.92)	**-0.066** (-0.85)	**-0.527** (-6.04)	**-0.260** (-4.37)	**-0.213** (-1.96)
ln (Female literacy)	**0.020** (0.51)	**0.028** (0.80)	**-0.916** (-4.67)	**0.075** (1.65)	**0.046** (1.00)	**0.149** (2.48)	**0.098** (2.04)	**0.068** (1.50)	**0.083** (1.04)
Female labour force participation rate	**-0.017** (-2.56)	**-0.004** (-1.80)	**0.018** (2.39)	**-0.014** (-1.60)	**-0.006** (-2.42)	**-0.021** (-6.98)	**-0.017** (-1.96)	**-0.008** (-2.64)	**-0.041** (-3.96)
Total fertility rate	**0.160** (4.19)	**0.230** (9.43)	**0.361** (6.86)	**0.235** (5.04)	**0.283** (9.35)	**0.302** (6.42)	**0.251** (5.32)	**0.277** (8.90)	**0.305** (4.29)
HIV prevalence rate	**0.041** (6.05)	**0.035** (7.51)	**-0.035** (-2.84)	**0.065** (9.70)	**0.051** (9.22)	**0.041** (8.72)	**0.066** (9.71)	**0.054** (10.88)	**0.09** (6.36)
Measles immunization rate	**0.0002** (0.24)	**-0.0003** (-0.41)	**-0.002** (-0.60)	**-0.001*** (-1.77)	**-0.001** (-1.30)	**-0.001** (-0.60)	**-0.001** (-1.11)	**-0.001** (-1.15)	**0.001** (0.71)
ln (ethnic fragmentation)	-	**0.027** (0.51)	**-0.293** (-2.72)	-	**0.076** (1.56)	**0.667** (6.35)	-	**0.073** (1.23)	**1.853** (0.94)
Eastern Africa dummy	**-0.295** (-1.81)	**-0.329** (-2.04)	**0.260** (0.46)	**-0.275** (-1.91)	**-0.367** (-2.26)	**-0.507** (-1.86)	**-0.297** (-1.94)	**-0.297** (-1.85)	**0.167** (0.82)
Central Africa dummy	-	**-2.353** (-2.60)	**5.879** (2.79)	-	**-3.374** (-2.46)	**-11.260** (-4.79)	-	**-3.112** (-2.07)	**-6.108** (-2.28)
Western Africa dummy	-	**0.259** (0.35)	**1.987** (0.68)	-	**-1.628** (-1.97)	**-10.657** (-6.54)	-	**-1.559** (-1.78)	**-5.452** (-2.42)
Eastern Africa dummy* ln (public health expenditure)	**0.044** (2.26)	**0.050** (2.55)	**0.126** (2.05)	**0.043** (2.36)	**0.055** (2.65)	**0.061** (1.91)	**0.049** (1.06)	**0.021** (0.44)	**0.137** (2.31)
Western Africa dummy* ln (public health expenditure)	**0.019** (0.51)	**0.031** (0.87)	**-0.725** (-2.82)	**0.148** (3.50)	**0.146** (3.27)	**0.159** (2.03)	**0.251** (2.27)	**0.207** (1.84)	**0.339** (2.85)
Central African dummy*	**0.104**	**0.112**	**-0.693**	**0.197**	**0.215**	**0.109**	**0.356**	**0.331**	**0.115**

ln(public health expenditure)	(2.39)	(2.69)	(-4.75)	(4.35)	(4.38)	(1.71)	(2.07)	(1.87)	(0.52)
Eastern Africa dummy* ln (private health expenditure)	**-0.028** (-1.67)	**-0.032** (-1.90)	**-0.142** (-2.98)	**-0.027*** (-1.81)	**-0.037** (-2.16)	**-0.044** (-1.69)	**-0.032** (-0.73)	**-0.007** (-0.15)	**-0.147** (-2.58)
Western Africa dummy* ln (private health expenditure)	**-0.047** (-0.86)	**-0.030** (-0.63)	**-0.532** (-2.27)	**-0.109*** (-1.74)	**-0.053** (-0.98)	**0.353** (3.51)	**-0.180** (-1.56)	**-0.119** (-1.06)	**-0.094** (-0.75)
Central African dummy* ln(private health expenditure)	**0.083** (1.19)	**0.035** (0.56)	**0.416** (2.48)	**0.064** (0.68)	**-0.024** (-0.32)	**0.451** (3.88)	**-0.111** (-0.51)	**-0.151** (-0.74)	**0.419** (1.81)
ln (corruption index)	-	-	-	**-0.141** (-2.95)	**-0.163** (-3.13)	**-0.252** (-3.31)	**-0.114** (-2.41)	**-0.166** (-3.42)	**-0.067** (-0.79)
Eastern Africa dummy* ln (corruption index)	-	-	-	**-0.021** (-0.58)	**0.026** (0.66)	**-0.153** (-2.13)	-	-	-
Western Africa dummy* ln (corruption index)	-	-	-	**0.198** (2.81)	**0.154** (2.01)	**0.231** (1.83)	-	-	-
Central African dummy* ln (corruption index)	-	-	-	**0.182** (1.47)	**0.170** (1.26)	**0.299** (1.84)	-	-	-
Eastern Africa dummy*corruption index* ln (public health expenditure)	-	-	-	-	-	-	**-0.003** (-0.19)	**0.011** (0.65)	**-0.043** (-2.19)
Western Africa dummy*corruption index* ln (public health expenditure)	-	-	-	-	-	-	**-0.039** (-1.19)	**-0.024** (-0.69)	**-0.083** (-2.13)
Central African dummy* corruption index* ln(public health expenditure)	-	-	-	-	-	-	**-0.088** (-0.98)	**-0.067** (-0.72)	**-0.026** (-0.23)
Eastern Africa dummy*corruption index* ln (private health expenditure)	-	-	-	-	-	-	**0.003** (0.18)	**-0.010** (-0.62)	**0.043** (2.22)
Western Africa dummy*corruption index* ln (private health expenditure)	-	-	-	-	-	-	**0.042** (1.20)	**0.027** (0.80)	**0.083**** (2.17)
Central African dummy* corruption index* ln(private health expenditure)	-	-	-	-	-	-	**0.089** (1.02)	**0.070** (0.77)	**0.023** (0.20)
Constant	**7.717** (9.06)	**5.987** (11.06)	**0.851** (0.83)	**7.933** (7.39)	**6.897** (11.39)	**8.371** (13.16)	**7.842** (7.15)	**7.265** (10.92)	**1.266** (0.19)
Number of Observations	362	362	362	251	251	251	251	251	251
F-Test, (p-value)	35.56 (0.00)	-	-	49.49 (0.00)	-	-	43.04 (0.00)	-	-
R-Squared	62.3	62.3	-	83.5	81.03	-	83.0	81.9	-
Wald Test χ^2, (p-value)	-	605.11 (0.00)	7473.42 (0.00)	-	811.80 (0.00)	36676.92 (0.00)	-	878.07 (0.00)	53454.40 (0.00)
Hausman test χ^2, (p-value)	17.95 (0.265)		-	52.35 (0.00)		-	86.54 (0.00)		-
Sargan Test χ^2, (p-value)	-	-	35.49 (0.27)	-	-	47.836 (0.80)	-	-	60.607 (0.35)
Arellano-Bond Autocorrelation test (AR) z-value (p=value)			1.523 (0.13)			0.098 (0.92)			0.651 (0.52)
Number of Instrumental Variables			50	-	-	80	-	-	83

Notes: 1) FE- Fixed Effects Model; RE- Random Effects Model; LDPD- Linear Dynamic Panel Data Model. 2) t-values are for the FE Estimation, and z-values are for the RE and LDPD estimations are shown in the parentheses. 3) Where p= are the probability values. 4) Instruments: Model 10 (two period lagged ln (public health expenditure) (GMM), ln (real GDP per capita) and the Eastern Africa dummy*ln (public health expenditure): levels, one period lagged ln (female literacy) (GMM), ln (real income per capita), Eastern Africa dummy*ln (public health expenditure), ln (private health expenditure), HIV prevalence rate, total fertility rates). Model 11 (two period lagged ln (private health expenditure) (GMM), the two period lagged ln (real GDP per capita) (GMM), ln (public health expenditure), the ln (female literacy), HIV prevalence rates, total fertility rates, Central Africa dummy*ln (public health expenditure), ln (corruption index), measles immunization rates: levels, the standard instruments are ln (public health expenditure), ln (female literacy), HIV prevalence rates, total fertility rate, Central Africa dummy* ln (public health expenditure), ln (corruption index) and measles immunization rates). Model 12 (two period lagged ln (private health expenditure) (GMM), four period lagged ln (real GDP per capita) (GMM) , four period lagged ln (corruption index) (GMM), ln (public health expenditure), ln (female literacy), HIV prevalence rates and total fertility rates: level, ln (female literacy), HIV prevalence rates and total fertility rates).

Table 12: Regional Variations of Public and Private Health Expenditure, and Corruption Influences on Under-Five Mortality Rates

Dummy variables for the Region takes the value of 1; 0 otherwise.			
Computation Based on LDPD Estimates			
Model 10a: Regional Variations of Public and Private Health Care Spending			
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
0.585	**0.711**	**-0.140**	**-0.108**
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.202	**-0.344**	**-0.734**	**0.214**
Model 11a: Regional Variations of Public and Private Health Care Spending and Corruption			
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.151	**-0.09**	**0.008**	**-0.042**
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.190	**-0.234**	**0.163**	**0.211**
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.257	**-0.410**	**-0.026**	**0.042**
Model 12a: Regional Variations of Public and Private Health Spending Efficacy (Interaction of Regional Dummy with Public and Private Health Expenditure and Corruption); Computed using CPI Values at the mean=3			
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.072	**-0.064**	**0.018**	**0.017**
Southern Africa	**Eastern Africa**	**Western Africa**	**Central Africa**
-0.081	**0.099**	**0.074**	**0.361**

Note: 1) Mean values of corruption index are extracted from the descriptive statistics; 3) the values of lnPHE, lnPrivHE and Regional Dummies are incorporated in the computation of regional effectiveness with the corruption index at the mean. Note Southern Africa is reference region in the estimations.