Do African Countries Get Health from Health Aid?[1]

Kwabena Gyimah-Brempong

Department of Economics
University of South Florida
Tampa, FL 33620
Tel: (813) 974-6520
email: kgyimah@usf.edu

and

IZA, Bonn

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Abstract

This paper uses panel data from African countries and a dynamic panel data (DPD) estimator to investigate the effects of health aid on health outcomes as well as the effects of health aid on health expenditures from domestic resources. I find that health aid has a small but statistically significant positive impact on health outcomes in African countries. Health aid is found to be more effective in improving health outcomes in countries with better governance. I also find that health aid marginally increases health expenditure from domestic sources in African countries, all things equal. The results are robust to several specifications and estimation methods.

KEY WORDS: HEALTH AID, HEALTH OUTCOME, DOMESTIC HEALTH EXPENDITURES, DPD ESTIMATOR, AFRICA

JEL: F35, I15, O, 019, O55

1 Introduction

Health aid or development assistance for health (*DAH*) to developing countries has increased substantially both in relative and absolute terms, in the last two decades. Between 1990 and 2012, *DAH* more than quintupled in absolute terms with aid to prevent and manage HIV/AIDS seeing a 35 fold increase.[1] Figures 1A–1C show the flow of *DAH*, source of *DAH*, and *DAH* to focus areas, to developing countries over the 1990–2011 period. Regardless of how health aid is measured, it is clear that the flow of health aid to the developing world, increased exponentially in the last three decades. Sub-Saharan Africa received the largest proportionate increase in *DAH* over the period with a 1,400% increase.

It is expected that this massive increase in health aid will improve health outcomes in recipient countries. However, there is no consensus as to whether increased *DAH* has improved health outcomes in Less Developed Countries (LDCs) generally, and Africa in particular, as disease burdens continue to be high.[2] Indeed in some areas, such as malaria, the disease burden seems to have changed little. This debate, summarized by Stuckler, McKee, and Basu (2013) has gathered momentum in recent years with increased volume of *DAH* to LDCs. This state of affairs naturally leads to the question as to whether LDCs get improved health outcomes from increased *DAH*.

At the same time, there is some evidence that health outcomes in African countries have improved in the last one to two decades. For example, the World Health Organization (WHO: 2013) reports that between 2000 and 2013, child mortality rates ($under5-m$) rate decreased by about 4.2% per year over the period. Similarly, an evaluation of the President's Emergency Plan for AIDS Relief for Africa (PEPFAR) indicates that mortality rates of AIDS patients as well as the rate of infections have declined dramatically (Batnaji and Bhattacharya: 2009). Could these improvements in health outcomes be partly attributed to increased inflow of *DAH* to African countries? Surprisingly there are few studies that comprehensively investigate the effects of this increase in health aid on health outcomes in African countries.

This paper uses panel data from a sample of African countries over the 1990–2012 period to investigate the effects of *DAH* on health outcomes. Specifically, it investigates whether *DAH* improves outcomes in child- (*under5-m*), maternal- (*maternal-m*), and cholera (*chol-m*) mortality rates, immunization rates against diphtheria, tetanus, and pertussis (*dpt3-im*), measles (*measles-im*), and improvements in tuberculosis treatment success rate (*TBtreat*). One reason given for the ineffectiveness of DAH (aid generally) by critics of health aid is that it reduces domestic resources to the health sector. Therefore I also investigate the effects of DAH on health expenditures from domestic resources.

This paper focuses on African countries for a variety of reasons. First, this region has the highest disease burden in the developing world. Second, it is a region that has received large infusions of DAH in the last two decades. With relatively low per capita health expenditure and high disease burden, the marginal effect of DAH should be higher than elsewhere, if DAH has significant effect on health outcomes. On the other hand, with low incomes and weak fiscal capacities, the likelihood that DAH substitutes for domestic health resources is much higher than in regions with stronger fiscal capacities. Finally, with low density of health care resources, it is possible that DAH may be ineffective in African countries since they lack the complementary inputs to render health inputs productive.

This paper makes many contributions to the literature: It is one of a few studies I am aware of that focuses specifically on the effects of DAH on a large number of health outcomes in African countries. Second, I use two measures of DAH and six health outcomes, thus allowing me to check the robustness of the results to the measurement of DAH and health outcomes. Third, I control for a large number of regressors including governance in the effectiveness of DAH. Fourth, I use panel data from a large number of African countries and employ a dynamic panel data (DPD) estimator that accounts for the endogeneity of some regressors and dynamics. Fifth, I investigate whether DAH effects differs between low and high DAH recipient countries. Finally, I investigate the effects of DAH on health expenditures from domestic sources in African countries.

The results of this paper are summarized as follows: Conditional on other health inputs, DAH has statistically significant positive impact on health outcomes in African countries; the effect is generally larger in countries with better governance. Furthermore, the effect of DAH on health outcomes is much more robust for low DAH countries than for high DAH countries. I also find that, contrary to the perception that DAH substitutes for domestic health resources, DAH is associated with increases in health expenditures from domestic sources. These results are robust to model specification, sample data, and measurement of DAH.

The rest of the paper is organized as follows: Section 2 provides a brief review of the health aid/health outcomes literature, section 3 introduces the equation I estimate, discusses the data and estimation methods, while section 4 presents and discusses the statistical results. Section 5 concludes the paper.

2 Previous Studies

There is a large empirical literature on the effects of health aid (and aid generally) on health outcomes in LDCs. This literature is part of the general aid effectiveness literature and can be grouped into three distinct categories ranging from macro to micro in focus. At the macro level are studies that investigate the effects of aggregate aid on health outcomes as part of aggregate aid effectiveness studies. At the other extreme end are studies focus on the effects of external aid to a specific disease—such as HIV/AIDS or maternal health—or the effects of a particular project on outcomes in that disease or health program. In the intermediate category are studies that focus on the effects of DAH on health outcomes. This study belongs to the intermediate category of studies. However to put the study in context, I briefly mention some of the studies in each category that may be relevant to this paper but I focus the literature review on the impact of DAH on health outcomes. falls in the former sub-category. because of the large volume of the literature on aid effectiveness, I only mention a few of the studies that are relevant to this paper.

There is no consensus in the literature on home aggregate aid affects health outcomes in recipient countries. Some studies investigate the effect of aggregate aid on health outcomes in LDCs and find positive and significant effects. Gormanee, Girma, and Morrissey (2005), using quantile regressions, finds that aggregate aid decreases infant mortality and the benefit of aid on human welfare are higher at lower income levels. Arndt, Jones and Tarp (2014) and Dalgaard and Hansen (2001) conclude that aggregate aid improves several development outcomes including reduction in infant mortality and improved nutrition. Other studies conclude that aggregate aid improves outcomes, including health outcomes, only in countries with good governance or policy environment (Burnside and Dollar: 2000, Chauvet, Gubert and Mesple-Somps: 2013, and Verschoor and Kalwij: 2006). Wolfe finds that aggregate aid improves public health delivery in health, education, water, and sanitation, These services improve health outcomes, all things equal.

On the other hand a large number of studies conclude that aggregate aid inflow has no significant impact on health outcomes in recipient countries. Boone (1996) finds that aggregate aid has no significant impact on any development outcome, including maternal and child mortality. Similarly, Easterly (2003) conclude that external aid has no significant effect on development outcomes, including health, whether one accounts for better governance/policy environment or not.

As in the aggregate aid effectiveness literature, there is no consensus on the effectiveness of *DAH* on health outcome; while some studies find a positive effect, others find no effect. Mishra and Newhouse (2009) finds that *DAH* significantly *reduces* infant mortality rates in LDCs. On the other hand, they find no evidence that aggregate aid has significant effect on infant mortality rates. They also find that *DAH* stimulates domestic spending on health in recipient countries and this may partly account for the effectiveness of *DAH*. Other studies finding significant positive effects include Feeney and Ouattara (2013), Afridi and Ventelou (2013) and Taylor *et al* (2013). Moullan (2013) argues that health aid (especially technical aid) decreases the emigration of doctors from aid recipient countries and thus may have positive consequences for health outcomes in these countries. Bendavid and Bhattacharya finds that increased *DAH* improves global health in recipient countries, all things equal. As in the aggregate aid effectiveness literature, some studies argue that *DAH* is effective in improving health outcomes only in countries that have good governance or policy environment (Farag *et al*: 2013, Fielding: 2011, and Hu and Mendoza: 2013). However, most studies do not condition *DAH* effectiveness on governance.

On the other hand, several studies find no significant impact of *DAH* on health outcomes in recipient countries. Using several estimation methods and panel data, Wilson (2011) finds no significant effect of *DAH* on infant and maternal mortality, as well as on life expectancy. Similarly, Mukherjee and Kizhakethalackal (2013) and Kizhakethalackal, Mukherjee, and Alvi (2013) find no significant effect of either aggregate *DAH* or various components of *DAH* on infant or maternal mortality rates as well as life expectancy. Biesman *et al* (2009) and Muldoon *et al* (2011) conclude that *DAH* improves the health sysytems of recipient countries and thus significantly impact infant and maternal mortality rates.

Finally, a third strand in the literature on *DAH* effectiveness focuses on the micro aspect of health aid—the effectiveness of health aid allocated to a particular disease or program on outcome in that sector or program, (eg. child- and maternal- mortality, or HIV/AIDS). Contrary to the macro and intermediate cases where there is disagreement on the effectiveness of aid, there seems to be a general agreement in the literature that targeted health aid significantly improves health outcomes in the targeted area. Shiffman *et al* (2009), Rasschaert *et al* (2011) and Bendavid and Bhattacharya (2009) find that health aid to support HIV/AIDS programs has significantly decreased the negative impacts (morality rate, infection rate, etc.) of the epidemic in African countries. Similarly, Taylor *et al* (2013) finds that *DAH* to support maternal health significantly reduces maternal mortality rates.

A sub-strand of the *DAH* effectiveness literature focuses on the distributional aspect of health aid. Bendavid (2014) finds that *DAH* benefits the poor more than it does the rich, hence he sees health aid as pro-poor. Similarly, Arndt, Jones and Tarp (2014), Gormanee, Girma and Morrissey (2005), Verschoor and Kalwij (2006), and Tacke and Waldman (2013) conclude that the impact of *DAH* on health outcomes is higher at lower incomes levels than at higher incomes, hence being pro-poor.

A related literature in the *DAH* effectiveness debate is what impact *DAH* has on health expenditures from domestic sources. A reason given for the (in)effectiveness of *DAH* is how domestic resources for health responds to increased inflow of *DAH*.[3] As in the aid effectiveness literature, there is no consensus on this subject. Some studies find that increased *DAH* stimulates increased spending on health from domestic resources (Mishra and Newhouse: 2009, Gormanee *et al*: 2005, Arndt *et al*: 2014, Verschoor and Kalwij: 2006), while others find that it is associated with reductions in domestic health expenditures (Lu *et al*: 2010, Boone: 1995, Dieleman *et al*: 2013, Dieleman *et al*: 2014, among others). Van de Sijpe (2013) argues that Lu *et al* (2010) does not account for off-budget health aid and once this has been accounted for, the purported fungibility of health aid disappears. Similarly, Batnaji and Bendavid (2012) dispute the fungibility assessment of Lu *et al*.

Antunes *et al* (2013) finds that budget support aid has no effect on government health spending but *DAH* partially replaces domestic government health expenditure. Dieleman and Hanlon (2014) argues that governments decrease domestic resources to health in periods when health aid inflow is increasing but do not restore the cuts during periods of decreasing health aid leading to fungibility of health aid over all. Shiffman *et al*, (2009) Mishra and Newhouse (2009) find that increased aid to HIV/AIDS prevention and management has significantly increased domestic resources on health in recipient countries although the composition of health expenditure has shifted away from other infectious disease control and health systems management towards HIV/AIDS.

While the fungibility literature focuses on how health aid channeled through the government affects government's spending allocation, my focus in this paper is on how health aid (through both government and non government channels) affects health outcomes and how domestic resources to health responds to health aid. Given that a large share of health aid is channeled through non-government channels, an emphasis on fungibility misses a large part of the effects of DAH on health outcomes and domestic resources mobilization for health. Furthermore, it is also likely that fungibility of health aid may improve health outcomes if the diverted funds are spent on sectors that enhance health outcomes, such as education, water, sanitation and income growth generally.

Some studies investigate the effects of government health spending on health outcomes in LDCs. Bokhari *et al* (2008) concludes that government spending elasticities on health outcomes in LDCs are positive and relatively large. Gupta *et al* (1999), Bhalotra (2007, 2010), Hu and Mendoza (2013), Farag *et al* (2013) as well as Gyimah-Brempong and Wilson (2004) find that public expenditures on health leads to reductions in infant mortality rates in LDCs. While these studies do not specifically address the effects of DAH on health outcomes, they provide a road map as to how health resources affect health outcomes in African countries. My approach is similar to the approach used by these researchers as well as those in the public expenditure literature.

None of the studies mentioned above estimates six health outcomes, focuses exclusively on Africa and, only a few use a dynamic panel estimator to investigate the effects of DAH on health outcomes. None also investigate the relative effectiveness of DAH in low and hight health recipient countries. They also do not investigate the effects of DAH on health expenditure from domestic sources.

3 Model, Data and Estimation Method

3.1 Model

I use six measures of health outcomes and two measures of health aid to investigate the effects of DAH on health outcomes in Africa. I follow earlier researchers (Mishra and Newhouse: 2009, Gormanee *et al*: 2005a, Mwabu: 2008, Cutler, Deaton and Lleras-Muney: 2006, Bhalotra: 2010, and Gyimah-Brempong and Wilson: 2004, among others) and specify a health production function that has traditional health production inputs and, following the works of Mwabu (2008), Mishra and Newhouse: 2009 and Cutler *et al* (2006), include DAH as an additional regressor.

Several challenges confound studies of DAH effectiveness; among them policy changes, lack of predictability of funds, differences in resource allocation across countries, and the relationships among donors and recipients of aid.[4] In spite of these challenges, there are several reasons why DAH may have significant effects on health outcomes. First, DAH may complement domestic health resources in a country and given the scarcity of health resources in Africa, may have a positive impact, if the marginal product of health resources is positive. Second, DAH may lead to increased domestic resource mobilization for the health sector, especially if domestic contribution is a requirement for of DAH (Gormanee *et al*: 2005, Mishra and Newhouse: 2009, Arndt, Jones, and Tarp: 2014, among others).

Third, DAH may come with technical and managerial skills that increases the productivity of domestic resources. These skills tend to be extremely scarce in African countries and their marginal products are therefore likely to be high. Fourth, DAH may come with new technologies (e.g. new medicines) or the improvements in existing technologies (e.g. new and improved versions of medical equipment or immunizations) thus improving the productivity of health resources. Finally, DAH may result in the reorganization of the entire health care system, hence increase the efficiency of health care delivery (Muldoon *et al*: 2011, Rasschnaert *et al*: 2011).

On the other hand, DAH could have non-positive consequences for health. Recipient countries may *substitute* DAH for domestic health resources and/or increase government consumption (Lu *et al*: 2010, Farag *et al*: 2009, Dieleman *et al*: 2013, Dieleman and Hanlon: 2014, among others). DAH may be diverted to create more bureaucracy, to private use, or lead to rent seeking activities. It could also lead to the mis-allocation of health resources in particular, and domestic resources generally, if DAH is given as specific inputs and the recipient country is not able to provide the necessary complementary inputs. It is also possible that large inflows of DAH could overwhelm the health care system and therefore reduce the ability to provide better health service.

Government health resources could be allocated to programs that complement those that are being supported by DAH instead of allocating resources according to their overall productivities in the health sector. Finally, DAH could lead to increased emigration of physicians and other health care professionals and this could have negative impacts on health outcomes (Moullon: 2013). Given these possible contradictions, we leave the sign of DAH as an empirical issue to be determined by the data.

I begin with the idea that health outcomes i in period t depends on DAH and a vector of other factors ($\mathbf{X}$) which will include the stock of health in a country. I specify the health outcome equation in a general functional form as: $health_{i,t} = f(DAH, \mathbf{X})$ where $health_{i,t}$ is health outcome i in period t, $\mathbf{X}$ is a vector of health production inputs and DAH is defined above. Variables contained in the $\mathbf{X}$ vector include domestic health expenditure, per capita GDP, population growth, governance, education, and the stock of health capital. These variables are those consistently found to be correlated with health outcomes across countries by earlier researchers. In the absence of a theoretical guide for the functional form of the outcome equation, I specify a linear functional form.

The health outcome equation I estimate is:

$$\begin{aligned} health_{i,t} &= \gamma_i + \tau_t + \alpha_1 DAH_{it} + \alpha_2 DAH \times ddomh_{it} + \alpha_3 DAH \times dgov_{it} \\ &+ \alpha_4 gdpcap_{it} + \alpha_5 popgrow_{it} + \alpha_6 educ_{it} + \alpha_7 health_{i,t-1} + \varepsilon_{it} \end{aligned} \tag{1}$$

where *ddomh* and *dgov* are health care expenditure from domestic resources and government effectiveness demeaned with their sample means respectively, *gdpcap, popgrow, educ* and $health_{i,t-1}$ are real per capita income, population growth rate educational attainment of adult women, and lagged health outcome respectively, γ_i, τ_t, and ε_{it} are country fixed effects, time varying fixed effects and idiosyncratic error terms respectively and α_{is} are coefficients to be estimated.[5] I include a lagged health outcome as a regressor given that previous period's health outcomes are likely to affect health outcomes in the current period. This variable also proxy for the stock of health capital as well as some omitted variables in the health outcome equation. Including the interaction of health aid and demeaned health expenditure from domestic resources and government effectiveness allows me to interpret the coefficient of DAH as the average effect of health aid on health outcomes at the sample means of health expenditure from domestic resources and government effectiveness.[6] In addition, I also include a series of time dummies to account for possible improvements in health technology that can affect health outcomes outside of health inputs.

My interest is in the sign and statistical significance of DAH. If DAH has a significant effect on health outcomes in African countries, I expect its coefficient to be statistically significant in the health outcomes equation. Furthermore, if better governance improves the performance of DAH as has been argued for aggregate aid, I expect the coefficient of $DAH \times dgov$ to be significant all things equal. The total effect of DAH on health outcomes is the sum of the direct effect of DAH (the coefficient of DAH) and the indirect effect through induced changes in health care delivery as a result of better governance and domestic health expenditure efficiency.

3.2 Data

The dependent variable in the equation I estimate is health outcome. It is difficult to provide a precise measure of "health" derived from the effects of health expenditure partly because health inputs improve an individual's feeling of better health. It is, however, not clear what "better health" means. For example, is long life with severe morbidity the same as one without morbidity or is the former better than a relatively short live without morbidity? Because of this, some researchers have attempted to use some utility-based measures of health outcomes such as quality adjusted life years (QALY), health years equivalent (HYE), and health utilities index (HIE). However, there are disagreements on the definition, measurement and implementation of these utility-based health outcomes that have not been resolved. Moreover, there is very little data on these utility-based health outcomes for African countries. I therefore use the "traditional" measures of health outcomes as my dependent variable.

I use six measures of health indicators to measure health outcomes in this study: under 5 mortality rate (*under5-m*), maternal mortality rates (*maternal-m*), cholera mortality rates (*chol-m*), the proportion of TB patients that are successfully treated (*TBtreat*), and immunization rates against measles (*measles-im*), tetanus, diphtheria, and pertussis (*dpt3-im*). I measure *under5-m* as the number of under 5 mortality per 1,000 children, *maternal-m* is measured as the number of maternal deaths per 100,000 births, while *chol-m* is measured as the proportion of cholera victims who do not survive the disease. *measles-im* and *dpt3-im* are measured as the proportion of children immunized against those diseases while *TBTreat* is measured as the proportion of tuberculosis patients successfully treated.[7]

Besides data availability, these health outcomes were chosen for the analysis because of the importance of their contributions to achievements of the 4th, 5th and 6th Millennium Development Goals (MDGs) in African countries. In addition, disease burdens in these areas are still very high by any standard in African countries. Progress towards improving these outcomes contribute greatly to the development of African countries. These health outcomes are more likely to reflect the effects of aid in the short to medium term than other measures of health outcomes, such as life expectancy at birth or adult morbidity rates (for which there is very little reliable data in African countries), which reflect combined long term effects of *DAH*, health investment, and life style choices made by individuals, over long periods. Data for the health indicators were obtained from World Health Organization (WHO) Data Observatory, various years.

The variable of interest in this paper is *DAH*. *DAH* is the sum of various functional components of health aid (medical education/training, medical services, basic health care, health care infrastructure, nutrition, HIV and other infectious disease control, health education, malaria control and tuberculosis control). I measure *DAH* in two ways—as the total net health aid disbursement to the health sector as a percentage of GDP (*DAHgdp*) and net health aid disbursement per capita (*DAH-cap*) from all sources.[8] Focusing on net aid disbursement ensures that I use aid *received* rather than health aid promised. Both ways of measuring *DAH* adjust for differences in country (economy) size. Data for *DAH* were obtained from the Institute of Health Metrics Evaluation (IHME) 2013 data set. This data set is comprehensive as it covers *DAH* from both government and non-governmental sources and provides information on the purpose of *DAH* (e.g. HIV/AIDS control/management, health infrastructure etc.) Unlike other sources, IHME tries to estimate and fill in missing values; thus providing full coverage of *DAH* data.

The control variables are per capita income (*gdpcap*), population growth rate (*popgrow*), health expenditure form domestic resources (*domh*), education (*educ*), and the policy environment which I proxy with *Governance Matters 2013* (World Bank) government effectiveness (*gov*). This governance variable is scaled from -6 to 6 with low numbers indicating poor governance and high numbers indicating good governance. I also use an alternative political stability (*polstab*) as an alternative measure of governance. The Governance Matter data series starts in 1996. To get data for pre-1996 period for this variable, I used a cubic time trend to estimate *gov* and *polstab* and used the coefficients to predict the pre-1996 values of these variables. I measure *educ* as the proportion of adult women in a country that has attended primary school.

(*gdpcap*) is real per capita GDP in 2000 PPP. Health expenditure from domestic resources (*domh*) is measured as the ratio of total health expenditure net of health aid to GDP.[9] *popgrow* is the annual growth rate of population for a country. The health expenditure data were obtained from the World health Organization Statistical Information System (WHOSIS), various years and complemented with data from IHME. Data on the remaining variables were obtained from the World Bank's *World Development Indicators, 2013* on line version. The data are annual observations for 48 African countries over the period 1990-2012.[10] The years of coverage and the countries included in the study are determined by the availability of data. A few countries had missing data for some variables for the earlier years so they were deleted from the sample, hence my data is an unbalanced panel. Where a country was missing a few observations in the middle of a period, I used multiple imputations to fill in the gaps.[11] As is the practice in most cross country regressions with short panels, I take 3 year averages of the variables for the regression analysis. Because the time frame is 23 years, the last period covers only a two-year period instead of three years. With 8 periods for each of the 48 countries, I have a total of 336 observations after losing some observations to missing values, for the regression analysis.

There are several problems associated with data from the major sources of *DAH* data (Van de Maele *et al*: 2013, Stuckler *et al*: 2013).[12] Health aid data sources differ in the comprehensiveness of what is covered as well as the duration of coverage. For example the most widely used source of *DAH* data—the OECD-DAC CRS—although comprehensive, mainly covers aid from government sources. With increasing *DAH* from non-governmental actors, such as the Gates Foundation, this becomes increasingly inaccurate source of *DAH* data. As Van de Maele *et al* (2013) points out, the fragmentary nature of *DAH* data collection implies that different data sources may provide different information for the same country. Finally, because part of general budget support aid may be allocated to the health sector in some countries and not others, it is very difficult to determine how much aid is allocated to the health sector (Struckler *et al*: 2013). The results, as with the results of all aid effectiveness studies, should be interpreted with these data problems in mind.

Summary statistics of the data are presented in table 1. The data shows that health outcomes in African countries are relatively low and highly variable. For example, the average under-5 mortality rate in the sample is 81 per 1,000 but with a range of 6.67 to 320. *DAHgdp* in the sample averages about 0.78% of GDP but with a large standard deviation. More important, health resources vary enormously across countries on the continent. For example,while health expenditure/GDP ratio averages about 5.8% in the sample, the ratio ranges from about 2% to 16%. Similarly, per capita health expenditure ranges from a low of $10.00 to a high of $ 469.00 in 2000 PPP. An interesting aspect of the data is that the mean of the governance variable is low, suggesting that African countries, on average had poor policy environments.

3.3 Estimation Method

The health outcome equation I estimate has endogenous regressors (DAH, $DAH \times ddomh$, $DAH \times dgov$) as well as a lagged dependent variable. In such cases, the fixed effect (FE) and the random effects (RE) estimators are not consistent. Under these circumstances, researchers have either used an instrumental variable (IV) or general method of moments (GMM) estimators to estimate such equations. A consistent estimator that has been used to estimate cross-country growth and other such regressions with endogenous regressors and lagged dependent variables in in a panel format is Arellano and Bond's Dynamic Panel Data (DPD) estimator (Arellano and Bond: 1991). This estimator is a GMM estimator that uses lagged levels of endogenous and predetermined as well as all exogenous regressors as instruments in a difference equation.

The DPD estimator consistently estimates dynamic panel data equations. However when the series are persistent, as social expenditure/GDP ratios and health outcomes are likely to be, lagged levels of endogenous and predetermined regressors tend to be weakly correlated with their subsequent first differences, thus leading to biased estimates on account of weak instruments. Blundell and Bond (1998) have introduced the "systems DPD" estimator to correct this problem. The "systems estimator" adds a levels equation with lagged values of first differences of endogenous and predetermined regressors as instruments to the difference equation and jointly estimate the two equations as a system. This improves the efficiency of the estimates. I use the efficient two-step estimator to estimate the health outcome equations. I implement Windmeijer's finite sample correction of standard errors and the reported "t" statistics are computed from this robust standard errors.

A major concern of the systems DPD estimator is the proliferation of instruments that leads to inefficient estimates (Roodman: 2009). In addition to restricting the number of lags to be used as instruments to the 3rd and 4th lags, I test for the validity of over-identifying restrictions using Hansen's **J** and **C** tests. If all regressors are exogenous, the DPD estimator produces consistent but inefficient estimates while the FE estimator produces both consistent and efficient estimates. As is normally done, I also test for the presence of second order serial correlation since the validity of the DPD estimates depend crucially on the absence of autocorrelated errors. All tests are based on small sample statistics. I estimate the equation in double logs, hence I interpret the coefficients as elasticities of health outcomes with respect to the estimators at their sample means.

4 Results

4.1 Initial Results

I estimate the equation in double log form so the coefficient estimates can be interpreted as elasticities.[13] The DPD estimates are presented in table 2. Column 2 presents the estimates for *under5-m*, column 3 the estimates for *TBtreat*, column 4 the estimates for *dpt3-im*, column 5 the estimates for *measles-im*, column 6 the estimates for *chol-m*, while column 7 presents the estimates for *maternal-m*. The regression statistics suggest that the model fits the data reasonably well. The F statistics indicates a rejection of the null hypothesis that all slope coefficients are jointly equal to zero at $\alpha = .01$. There is no evidence of second order serial correlation in the error terms. The Hansen J statistic does not lead to a rejection of the over-identifying restrictions at any reasonable degree of confidence. Similarly, the difference Hansen test (C statistics) shows that with the exception of the *under5-mort* equation, I cannot reject the null of the validity of exclusionary restrictions at $\alpha = 0.05$ for all equations.

The estimated elasticity of *under5-m* with respect to *DAHgdp* in column 2 is negative, and significantly different from zero at $\alpha = .01$, suggesting that all things equal, *DAH* decreases child mortality rates in African countries. A one percent increase in *DAH* decreases the mean child mortality rate by about 0.99 percent, all things equal. With a mean under-5 mortality rate of 81.9 per 1,000 in the sample, the estimate suggests that a 1% increase in health aid/gdp ratio *decreases* under-5 mortality by about 0.80 per 1000 at the sample means of health expenditure from domestic resources and government effectiveness—a non-trivial number of lives saved considering that the mean *DAHgdp* in the sample is only 0.78%. Similarly, the estimated elasticities of *maternal-m* and *chol-m* with respect to *DAHgdp* are negative and significantly different from zero at $\alpha = .05$ or better, indicating that *DAH* significantly decreases cholera and maternal mortality rates, all things equal. In columns 3-5, the elasticity estimate of *DAHgdp* is positive and statistically significant at $\alpha = .05$, indicating that all things equal, *DAH* has significantly positive impacts on the success of TB treatment, and *dpt3-im* and measles immunization rates. The impact elasticities at the means of *domh* and *goveffect* ranges from about 0.12 for *TBTreat* to 0.93 for *dpt3-im* rate.

The estimates are similar to the results of earlier research that finds that health aid significantly improves health outcomes in developing countries (Arndt, Jones, and Tarp: 2014, Gupta *et al*: 1999, Gyimah-Brempong and Wilson: 2004, Mishra and Newhouse: 2009, Gormanee *et al*: 2005, Bendavid and Bhattacharya: 2009, Farag *et al*: 2013, Feeney and Ouattara: 2013, Taylor *et al*: 2013, Verschoor and Kalwij: 2006, among others). The result is, however, inconsistent with the results of studies that find no significant *DAH* impact on health outcomes in recipient countries (Boone: 1996, Lu *et al*: 2010, Mukherjee and Kizhakethalackal: 2013, Wilson: 2011, Kizhakethalackal *et at*: 2013, among others).

The coefficient of $DAH \times ddomh$ in columns 2, 6, and 7 is negative and, with the exception of the *measles-im* equation, significantly different from zero at $\alpha = .05$, suggesting that interaction of DAH and health expenditure above the sample mean significantly decreases child, cholera, and maternal mortality rates, in African countries. The coefficient of the interaction term in column 4 is positive and significant at $\alpha = 0.05$ suggesting that indicating that the interaction between DAH and domestic health expenditure above the sample means is associated with higher rates of *dpt3-im* rate. The estimate of the interaction term in the other equations is not significant. The significant coefficient of $DAHgdp \times ddomh$ suggests that health aid is more effective in countries that significantly increase domestic health spending to complement *DAH*. The estimated effect of the interaction term on health outcomes I find here is consistent with the results of previous research that finds that increased domestic health expenditures lead to better health outcomes in LDCs (Bhalotra: 2007, 2009, Arndt, Jones and Tarp: 2014, Bokhari *et al*: 2007, Gupta *et al*: 1999, Wolfe: 2006, Feeney and Ouattara: 2013, Farag *et al*: 2013, Gyimah-Brempong and Wilson: 2004, Cutler, Deaton, and Lleras-Muney: 2006, among others).

The estimate of the interaction between *DAH* and *dgov* generally has the same sign as that of *DAHgdp* in the equations, but is only significantly different from zero at $\alpha = .05$ in the $dpt3 - im$ and *maternal-m* equations. These estimates suggest that in addition to the direct effect, *DAH* is more effective in countries with better governance. This estimate is consistent with the conditional effectiveness of aid; however, the overall effect of DAH is also consistent with the unconditional effectiveness hypothesis. The result is also consistent with the results obtained by Bokhari *et al* (2007), Farag *et al*: (2013), Fielding: 2011, Hu and Mendoza (2013), and Rajkumar and Swaroop (2008). It is also generally consistent with the results that foreign aid is generally more effective in countries with good governance (Burnside and Dollar: 2000).

The coefficient of *lag.health* is positive, relatively large in most cases, and significantly different from zero at $\alpha = .01$, suggesting that health indicators in the current period are highly influenced by health outcomes in previous periods, a result that is consistent with theoretical expectations and the results of previous research. While the coefficient estimates of *lag.health* is relatively large, it is less than unity, indicating a stable relationship between health outcomes and the regressors. The coefficient of time is generally significant at $\alpha = .05$ or better suggesting that health outcomes in African countries improved independently of the regressors, probably due to innovations in medical technology over, time during the sample period

Coefficients of the control variables are of the expected signs. In particular, the coefficients of *gdpcap* and *educ* are negative and significant in the *under5-m*, *chol-m* and *maternal-m* equations, while they are positive and significant at $\alpha = .05$ in the other equations. The significant coefficient of *educ* suggests that an important way of improving health outcomes in African countries is education of females. These coefficient estimates are also consistent with the results of previous research and suggest that good governance has positive effects on health indicators in Africa, all things equal.

The estimates above are based on measuring *DAH* as health aid/GDP ratio. It is possible that my results depend on the way *DAH* is measured. I therefore estimate the equations using health aid per capita (*DAHcap*) as my measure of *DAH* to see if the results change. For consistency, I measured *ddomh* as deviation of per capita health expenditure from domestic resources in 2000 PPP from the sample mean of this variable. The results are presented in table 3. As in table 2, columns 2–7 present the estimates for *under5-mort*, *TBTreat*, *dpt3-im*, *measles-im*, *chol-m*, and *maternal-m* respectively. There is no evidence of second order serial correlation in the error terms, and both the Hansen **J** and **C** statistics do not reject the null hypothesis of the validity of the over-identifying restrictions. I reject the null hypothesis that all coefficient estimates are jointly equal to zero at $\alpha = .01$ on account of the F statistics, for all equations.

The results in table 3 are *qualitatively* similar to those presented in table 2. As in table 2, the elasticity estimate of *DAHcap* is negative and significant at $\alpha = .05$ in the *under5-m*, *chol-m*, and *maternal-m* equations, indicating that health aid decreases under5-, cholera-, and maternal mortality rates in African countries. The coefficient estimate of *DAHcap* in the *TBTreat*, *dpt3-im* and *measles-im* is positive and significant at $\alpha = .05$ in all these equations. This implies that at the means of per capita health expenditure from domestic resources and government effectiveness, per capita health significantly affects health outcomes in African countries. Given that the average per capita health aid is small, these estimates are reasonable as can be expected.

The coefficient of $DAHcap \times ddomh$ is negative and significant in the *chol-mort* and *maternal-m* equations while it is positive and significant in the *measles-im* equations. It is insignificant in the other equations. The coefficient of $DAHcap \times dgov$ interaction term is negative in the *under5-mort, cholera-mort*, and *maternal-m* equations but only significant in the *under5-mort* and *cholera-mort* equations; it is positive and significant in only the *measles-im* equations. In addition, the estimates of the control variables have the expected signs and most of them are significant at $\alpha = .05$. The estimates suggest that the effect of *DAH* on health outcomes I find does not dependent on the measurement of *DAH.*

Measuring health aid as *DAHgdp* and *DAHcap* provides *qualitatively* similar results. However, the estimates based on *DAHgdp* are generally more precise than their *DAHcap* counterparts. Moreover, most of previous research on the subject measure health aid as *DAHgdp*. Therefore I use the estimates in table 2 as my preferred results and will base further discussions on measuring health aid as *DAHgdp*.

4.2 Robustness Tests

The results in Section 4.1 above indicate that *DAH* has significant effects on health outcomes in African countries, all things equal. It is possible that the results depend on specification of the equation or sample data I use. I therefore conduct some robustness tests in this sub-section. First I enter *DAH* in a quadratic form to test the possibility of a non-linear relationship between *DAH* and health outcome. Second, I estimate a health outcome equation that uses political stability (*polstab*) as my measure of governance. Finally, I divide the sample into high and low *DAH* countries and estimate the equation for each subsample to see if the results differ across the two sub-samples. I define high aid countries as those with *DAH* greater than the median health aid for the sample while low health aid countries are those with health aid that is less than the median for the sample. The results of these robustness tests are presented in tables 4 and 5. Panel A of table 4 presents the estimates for the quadratic specification and panel B presents the estimates based on measuring governance as *polstab*. Table 5 presents the estimates for the high/low *DAH* breakdown of the sample.[14].

Regression statistics indicate a reasonably good fit as there is no evidence of second order serial correlation of error terms and the Hansen tests do not reject the over-identifying restrictions. The estimates are of the expected signs and most of them are significant at $\alpha = .05$. In panel A, the elasticity estimates are *qualitatively* similar to the estimates in table 2. The estimates of *DAHgdp* and $DAHgdp \times dgov$ are of the expected signs and significant at $\alpha = 0.05$; however, the quadratic term of *DAHgdp* is not significant at in any of the health outcome equations. The estimate of $DAHgdp \times ddomh$ is significant at $\alpha = .05$ in only the *TBtreat* and *maternal-m* equations. The coefficient of $DAHgdp \times dgov$ is insignificant in all health outcome equations. In addition to the coefficient estimates, χ^2 test to test the equality of the estimates in tables 2 and the quadratic form in panel A of table 4 could not reject the null of equality of the two equations.[15] This suggests that my results are not dependent on the linear specification I use.

Panel B reports the estimates of the health outcome equations that use *polstab* as the measure of governance. Similar to the estimates in panel A, regression statistics suggest a good fit to the data. The estimate of *DAHgdp* is of the expected sign and significant at $\alpha = .05$ in all health outcome equations. The estimate of $DAHgdp \times ddomh$ is significant in only the *under5-m, dpt3-im* and *measles-im* equations while that of $DAHgdp \times dgov$ is only significant in in the *TBtreat* equation. The estimates in panels A and B of table 4 suggest that my results that DAH has significant impact on health outcomes in African countries does not depend on model specification.[16]

Do my results depend on the sample data I use to estimate the equation? The estimates for low and high *DAH* recipient countries are presented in table 5. Panel A presents the estimates for low *DAH* sub-sample while Panel B presents the estimates for high *DAH* sub-sample. The mean DAHgdp for low *DAH* countries is 0.23% while the high *DAH* countries have a mean of 1.44%. The estimate for *DAHgdp* is of the expected sign and significantly different from zero at $\alpha = .05$ in all equations in both low and high *DAH* countries. Most of the estimates of $DAHgdp \times ddomh$ and $DAHgdp \times dgov$ are insignificant at conventional levels in both subsamples. I note that the absolute magnitude of the estimates for low *DAH* countries are higher than those of high aid countries. The estimates from both sub-samples are, however, *qualitatively* similar to their counterparts in table 2. I therefore conclude that my result that *DAH* has significant impact on health outcomes in African countries does not depend on the sample I use.

4.3 Health Aid and Domestic Health Expenditure

Lu *et al* (2010) argue that *DAH* decreases public health expenditure from domestic resources in recipient countries. They calculate that for every $1.00 increase in *DAH*, public health expenditures from domestic sources decrease by between $0.43 to $1.14. Similarly Farag *et al* (2009) and Dieleman and Hanlon (2014) find strong substitution effect between *DAH* and domestic health expenditures. However, Batnaji and Bendavid (2012) dispute this result on account of unreliable data, especially the use of a few extreme outliers in the analyses. Van de Sijpe (2013) argues that once one accounts for the existence of off-budget health aid, the fungibility of health aid found by Lu *et al* disappears. Grepin (2012) finds that increased aid to HIV/AIDS decreases immunization rates but mildly increases expenditures on some maternal health services in Sub-Saharan Africa. The effect is much larger in countries with lower density of health care professionals. This suggests that increased aid to HIV/AIDS crowds out the delivery of other health services.

DAH may substitute for domestic resources or make it possible for policy makers to shift domestic resources to other sectors; it may also generate additional health resources from domestic sources to complement health aid. I briefly investigate the effects of DAH on health expenditures from domestic resources by estimating a domestic health expenditure equation with DAH as an additional regressor. The general form of the equation I estimate is: $domh = h(DAH, \mathbf{Z})$ where $domh$ and DAH are defined above, and $\mathbf{Z}$ is a vector of other variables that determine $domh$ in a country. Variables in $\mathbf{Z}$ include governance, per capita income and its growth rate (*gdpcap, gdpcagrow*), population growth rate, and lagged domestic health expenditure. I specify and estimate the $domh$ equation in a linear form as:

$$\begin{aligned} domh &= \zeta_i + \lambda_t + \beta_1 DAHgdp_{it} + \beta_2 DAHgdp_{i,t-1} + \beta_3 popgrow_{it} + \beta_4 gdpcap_{it} \\ &+ \beta_5 gdpcapgrow_{it} + \beta_6 domh_{i,t-1} + \beta_7 time + \beta_8 DAH \times dgov_{it} + \epsilon_{it} \end{aligned} \tag{2}$$

where all variables are defined above and ϵ is a stochastic error term. I include $DAHgdp_{i,t-1}$ as a regressor because it may take African countries some time to mobilize domestic resources for health in response to changes in *DAH.*

I am interested in the sign and significance of the coefficient on DAH in this equation. If DAH completely substitutes for *domh*, I expect the coefficient of DAH to be zero or negative and significant; it will be positive if DAH increases *domh*, all things equal. I cannot sign DAH *a priori*, given the arguments provided in the introduction of the paper, hence I leave it as an empirical issue to be determined from the data.

I use the DPD estimator to estimate the $domh$ equation. The results are presented in table 6. Column 2 presents the estimates for *domhgdp* while column 3 presents the estimates for *domhcap*, where *domhgd* and *domhcap* are health expenditure from domestic resources as a ration to GDP and per capita respectively.[17] Regression statistics suggest a reasonably good fit to the data. There is no second order serially correlated error terms, the F statistics leads to a rejection of the null hypothesis that all slope coefficients are jointly equal to zero, and the Hansen J and C statistics do not reject the over-identifying restrictions.

The coefficient of DAH in the current period is negative in both equations but statistically significant at $\alpha = .05$ in only the *domhgdp* equation, suggesting that DAH has no contemporaneous effect on per capita health expenditures from domestic sources in African countries. However, the negative and significant coefficient of DAH in the *domhgdp* equation suggests that *DAHgdp* has a contemporaneous negative effects on *domh*, a result that is consistent with the fungibility hypothesis. The coefficient of DAH_{t-1} in both equations is positive, large relative to the estimated coefficient of contemporaneous DAH and significant suggesting that DAH increases health expenditure from domestic resources with a period lag. The combined contemporaneous and lagged effects of DAH is positive and significant and suggests that DAH stimulates additional health expenditure from domestic resources. This is inconsistent with fungibility of health aid. The coefficient of $DAH \times dgov$ is positive but only significant in the *domhgdp* equation suggesting that DAH may stimulate additional domestic health expenditure when there is good governance.

The estimates suggest that, contrary to what the critics of aid argue, DAH induces more health spending from domestic resources in African countries, all things equal. The results are consistent with earlier research that finds that DAH increases domestic resources to the health sector (Verschoor and Kalwij: 2006, Shiffman *et al*: 2009, Mishra and Newhouse: 2009, Bendavid and Bhattacharya: 2009, Feeney and Ouattara: 2005, Taylor *et al*: 2013, Rasschaert *et al*: 2011, Van de Sijpe: 2013). It is not consistent with studies that find that DAH has a negative effect on domestic health care expenditures in recipient countries (Lu *et al*: 2010, Dieleman *et al*: 2013, Dieleman and Hanlon: 2014, Farag *et al*: 2009, Boone: 1995, among others). While I find that DAH stimulates more domestic spending on health in Africa, I do not investigate the composition of this increased health expenditure as Shiffman *et al* (2009) and Biesman *et al* (2009) do.

The estimates of the control variables have the expected signs and, with a few exceptions, are statistically significant at conventional levels. In particular the coefficients *gdpcapgrow*, and lagged *domh* are positive and significant in the *domhgdp* equation, while the estimates for *gdpcap, lag.domh*, and $DAH \times dgov$ are positive and significant in the *domhcap* equation. The estimates for all other variables in both equations are statistically insignificant. The relatively large significant coefficient of *lag.domh* indicates a very strong persistence of the proportion of national income devoted to health expenditure in African countries.

What might explain the positive relationship between DAH and health expenditures from domestic resources in African countries I find? It is possible that the delivery mechanism for DAH may be partly responsible for this result. Given the low capacity of African governments to implement health programs, a large proportion of health aid is channeled through non-governmental organizations making it impossible for governments to redirect these funds. Second, I measure domestic health resources to include both private and public expenditures. It is possible that total health expenditures (public and private) may be constrained by supply factors. When *DAH* increases supply of health services, it may elicit increased health spending (induced demand), especially from private sources. Third, fungibility is likely to be high if health aid funds existing programs or what the government would have funded regardless of aid. If better targeting results in funding only new programs or only the *expansion* of existing programs–a distinct possibility in African where health resources are extremely scarce–*DAH* is more likely to be an addition to, rather than a replacement of existing expenditures. Finally, the Millennium Development Goals (MDGs) require African countries to increase their own expenditures on the social sector. This is not likely to be achieved if African countries shift health aid to sectors unrelated to health.

My results that *DAH* has significant effects on health outcomes in African countries should interpreted with caution. First, it is limited to African countries—a set of countries that have low health expenditures and have seen large infusion of *DAH* in the last two to three decades. The results may therefore not be generalizable to regions that have relatively higher health expenditures and receive lower inflows of health aid. Second, I am not able to analyze a large number of health outcomes, including HIV/AIDs and malaria prevention that have attracted large inflows of health aid. Perhaps, application to these other health outcomes may lead to different results. Third, while I find that *DAH* has positive effects on health outcomes in Africa, I do not investigate the transmission mechanism through which this effect occurs—mechanism that may be of policy interest. Finally, one has to worry about measurement errors in the health aid data in African countries, especially given the way I constructed some of the variables. Also, a large number of African countries participated in the Highly Indebted Poor Countries (HIPC) initiative initiative during the sample period; an initiative that required beneficiary countries to reallocate funds from debt relief to the provision of social services, including health. This may affect my results.

This paper does not investigate *efficiency* of the health sector. It is possible that increased resource flow to the health sector may decrease the productivity of health care resources at the margin. This issue is left for a future research project. Although I find that *DAH* improves health outcomes in African countries, it may be necessary to improve the efficiency of health care delivery, and indeed public service delivery in general in African countries. After all, as Mundell (2014) argues, health aid can only act as catalyst for generating increased domestic healt resources rather than a replacement for domestic resources.

5 Conclusion

This paper investigates the effects of health aid on health outcomes in African countries. Using 6 measures of health outcomes and two measures of health aid, I find that health aid has statistically significant impact on health outcomes in African countries. The result is robust to the *measurement* of health aid, level of health aid, as well as model specification. The paper also finds that increased health aid leads to increased health expenditures from domestic sources in African countries.

An important development goal is to improve health in developing countries. For African countries with relatively low health outcomes and health resources, the results suggest that targeting aid to the health sector could be beneficial and that the current donor emphasis on health may be well placed. The relationship between *DAH* and health outcomes is much stronger in countries with better governance. This suggests that improving governance may also be good for health. The results show that health aid is more effective in low *DAH* countries than in high *DAH* countries. If that is the case, African countries cannot rely on ever increasing levels of health aid to solve their health problems in spite of the positive effect of health aid I find in this paper. African countries may have to find ways to increase health resources from domestic sources.

The fact that *DAH* leads to increased health expenditure from domestic sources implies that *DAH* may be even more productive in improving health outcomes in African countries than the direct effect of *DAH* implies. Perhaps the aid effectiveness debate should focus on finding innovative ways (such as the use of modern telecommunications) to *improve the efficiency of public service delivery generally*, rather than on a narrow focus on the impact of aid. The results also suggest that researchers should factor in the domestic resource mobilization effect of *DAH* when investigating the effects of *DAH* on health outcomes, otherwise they will under-estimate the effectiveness of *DAH*.

The results should, however, be viewed with caution. It is possible that different measures of health outcomes may produce different results. It is also possible that aid to the health sector may be measured with a large error and that *aid to other sectors* could be shifted to the health sector (or vice versa). These situations could affect my results. It is also possible that different estimators besides the DPD could produce different results. Finally, while I find a statistically significant effect of health aid on health outcomes, I do not investigate which *type* of health aid is responsible for improvement in health outcomes. This may have more important aid policy implications than knowing that DAH has positive effects on health outcomes.

6 Notes

1. Based on IHME DAH 2013 data base quoted from World Health Organization Statistical Information Systems (WHOSIS).

2. I use LDCs and developing countries interchangeably to mean the same set of countries which the World Bank characterize as less developed countries.

3. A strand of the literature not pursued here is how aid for a specific disease burden substitute for health aid or domestic resources for fighting other diseases.

4. See Alvarez and Acharya (2012) for a discussion of challenges in heath aid effectiveness research.

5. I define and measure *ddomh* as: $ddomh_{it} = domh_{it} - \overline{domh}$, where $\overline{domh}$ is the sample mean of *domh*. *dgov* is similarly defined.

6. This specification is similar to what has been used in the program evaluation literature. See for example Bleakley, H. (2010), "Malaria Eradication in the America: A Retrospective Analysis of Childhood Exposure", *American Economic Journal: Applied Economics*, **2** (2), 1–45, and Lucas, A. (2013), "The Impact of Malaria Eradication on Fertility", *Economic Development and Cultural Change*, **61** (3), 607–631.

7. While HIV/AIDS has received the most health aid in Africa during the sample period, there is very little data on HIV outcomes in African countries hence I do not include it in this study.

8. Increasingly large share of health aid is coming from the private sector, such as the Gates Foundation. Excluding these sources will lead to a mis-measurement of health aid.

9. Where data for *domh* was not available from the World Health Organization sources, I derived it as a residual from total health expenditure and health aid. It is calculated as $(health \quad expenditure - DAH)/GDP = health \quad exp/GDP - DAHgdp$. This makes *domh* orthogonal to *DAH*. We define per capita domestic health expenditure similarly.

10. The countries in the sample are Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Cote d'Ivoire, Comoros, Democratic Republic of Congo (DRC), Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Togo, Uganda, Tanzania, Tunisia, Zambia, and Zimbabwe. The sample used for this study are dictated by the availability of the requisite data.

11. There were about a total of 5 annual such imputations involving two countries.

12. The leading sources of health data include OECD-DAC Credit Reporting System, World Health Organization, World Bank, Regional Development Banks, and IHME.

13. To avoid taking the logs of negative values, I log-transformed variables that have negative values in the following way: $log(X - (X_{min} - 1))$ where X_{min} is the minimum value taken by X.

14. I only present the estimates for the coefficients of DAH, $DAH \times ddomh$ and $DAHgdp \times dgov$, for space consideration. The full estimates are available upon request.

15. The calculated χ^2 statistics are 2.08, 1.92, 3.31, 0.98, 1.42, and 1.88 for *under5-m, TBTreat, dpt3–m, measles-im, chol-m*, and *maternal-m* respectively.

16. Other specifications, not reported here but available upon request, show similar results.]

17. To conserve space, I only present the estimates of the coefficients of DAH, $DAH \times ddomh$ and $DAH \times dgov$.

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Table 1: **Summary Statistics of Sample Data**

Variable	Mean*	Standard Deviation	Minimum	Maximum
Health	**Outcomes**			
$under5-m$ (per 1,000)	81.87	60.51	6.67	320.33
$TBtreat$ (%)	75.35	14.48	1.00	100.00
$dpt3-im$ (%)	76.86	19.57	16.00	99.00
$measles-im$ (%)	76.68	19.42	0.00	99.00
$chol-m$ (%)	3.11	4.01	0.00	31.65
$maternal-m$ (per 100,000)	423.05	316.92	22.00	2400.00
Health	**Aid &**	**Expenditure**		
$DAHgdp$ (%)	0.78	1.17	0.02	8.357
$DAHcap$ (PPP_{2000})	126.57	157.08	10.00	469.00
$domh$ (%)	5.76	2.38	1.97	16.29
$healthexp$ ($ (PPP_{2000})	6.09	2.09	1.03	62.90
Control	**Variables**			
$popgrow$ (%)	2.43	1.08	-7.91	9.80
$gdpcap$ (PPP_{2000})	2213.78	2793.65	200.00	16620
$gdpcapgr$ (%)	1.243	6.453	-17.08	17.13
$educ$ (%)	77.56	20.69	14.11	99.32
gov	-0.548	0.891	-2.32	1.91
$polstab$	-0.468	0.891	-2.914	1.432
N	336			

* these are unweighted averages.

Table 2: DPD Estimates of Health Outcome Equations

Variable	$under5-m$ (2)	$TBtreat$ (3)	$dpt3-im$ (4)	$measles-im$ (5)	$cholera-m$ (6)	$maternal-m$ (7)
$DAHgdp$	-0.9888**	0.1181**	0.9284***	0.3925**	-0.5200**	-0.3684***
	(2.22)	(2.74)	(2.82)	(1.95)	(2.09)	(3.10)
$DAHgdp \times ddomh$	-4659**	0.0462**	0.0648**	-0.2744	-0.0189***	-0.0321**
	(1.79)	(2.18)	(1.89)	(0.44)	(3.02)	(2.82)
$DAHgdp \times dgov$	0.5929	-0.0107	0.0988**	0.5265	-0.2087	-0.4202**
	(1.18)	(1.62)	(1.80)	(1.46)	(0.65)	(2.69)
$gdpcap$	-0.0548**	0.4987***	0.4929***	0.4777***	-0.8537**	-0.1083**
	(2.55)	(4.10)	(3.01)	(3.41)	(2.00)	(1.88)
$popgrow$	0.3098***	-0.1670***	-0.1405	-0.2794**	0.6591***	0.6414***
	(5.11)	(3.65)	(0.58)	(4.51)	(7.98)	(6.50)
$educ$	-0.1443**	0.1075**	0.0918**	0.1097***	-0.5499****	-0.0275**
	(1.92)	(2.57)	(1.96)	(2.98)	(4.67)	(2.43)
$lag.health$	0.4882***	0.3438***	0.5039***	0.5047***	0.1357***	0.7844***
	(14.22)	(2.95)	(4.35)	(3.06)	(7.44)	(41.32)
$time$	-0.0037**	-0.0041	0.0063**	0.0017	0.0193	-0.0659***
	(1.98)	(0.69)	(2.27)	(0.32)	(0.26)	(4.17)
N	336					
F	5334.74	3741	5237.00	281.40	268.07	2812
AR(2) $p-value$	0.343	0.819	0.201	0.444	0.38	0.31
Instruments	41	38	41	42	64	24
Hansen J test	51.37	37.51	37.93	38.67	46.46	25.15
$p-value$	0.129	0.492	0.608	0.618	0.952	0.682
Diff. Hansen	6.76	22.60	20.43	25.89	26.68	10.15
$p-value$	0.986	0.425	0.253	0.413	0.968	0.603

Dependent Variable: Health Outcome

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 3: **DPD Estimates of Health Outcome Equations: Healthaidpercap**

Variable	$under5-m$	$TBtreat$	$dpt3-im$	$measles-im$	$chol-m$	$maternal-m$
	(2)	(3)	(4)	(5)	(6)	(7)
$DAHcap$	-0.0373**	0.0333**	0.0473**	0.0844**	-0.1625***	-0.0383**
	(2.53)	(2.35)	(2.35)	(2.66)	(4.57)	(2.22)
$DAHcap \times ddomh$	-0.0632	-0.1082	0.1129**	-0.0245	-0.2197**	-0.0632**
	(0.95)	(0.52)	(1.98)	(0.76)	(2.16)	(1.95)
$DAHcap \times dgov$	-0.0103***	-0.8976	-0.0026	0.0085***	-0.0281**	-0.0064**
	(3.21)	(0.59)	(1.02)	(3.96)	(2.01)	(0.66)
$gdpcap$	-0.0299**	0.3544***	0.2646***	0.2532***	-0.0532	-0.0299**
	(2.18)	(4.70)	(3.20)	(3.71)	(0.45)	(1.98)
$popgrow$	0.1098**	-0.2070***	-0.0536**	-0.2794**	0.8702***	0.0844**
	(2.11)	(3.65)	(2.58)	(4.51)	(2.91)	(2.32)
$educ$	-0.0312**	0.1329**	0.0322	0.1567**	-1.0058****	-0.1548**
	(2.51)	(2.63)	0.352)	(1.99)	(8.76)	(2.02)
$lag.health$	0.9742***	0.5872***	0.7441***	0.6200***	0.10547***	0.8743***
	(15.17)	(8.26)	(10.75)	(6.03)	(5.15)	(12.87)
$time$	-0.0082**	0.0028**	0.0025*	-0.0036	-0.0137**	-0.0709**
	(1.98)	(2.08)	(1.62)	(0.56)	(2.16)	(2.11)
N	336					
F	3546.70	141.89	1493.90	6171	198.68	3546
AR-2 $p-value$	0.24	0.489	0.138	0.457	0.24	0.438
Instruments	26	28	42	29	31	26
Hansen J test	25.66 [22]	26.38	41.62	19.86	18.92	18.28
$p-value$	0.368	0.552	0.488	0.897	0.512	0.139
Diff. Hansen	16.34	17.64	26.12	13.05	12.08	15.91
$p-value$	0.034	0.412	0.389	0.365	0.319	0.531

Dependent Variable: Health Outcome

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 4: **Quadratic Specification & *Polstab* as Governance Measure**

	$under5-m$	$TBtreat$	$dpt3-im$	$measles-im$	$cholera-m$	$maternal-m$
	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A:	**Quad.**		**Specification**		
$DAHgdp$	-0.4057**	0.1738**	0.5338**	0.0313**	-0.0776**	-0.5515**
	(1.89)	(2.41)	(1.88)	(2.16)	(2.18)	(2.10)
$DAHgdpsq$	-0.0073	-0.0069	-0.0091	-0.0046	0.0174	0.0042
	(1.05)	(0.84)	(1.19)	(0.48)	(0.79)	(038)
$DAHgdp \times ddomh$	-0.0257	0.0264**	0.0402	-0.0697	-0.917	-0.0286**
	(0.56)	(1.72)	(1.24)	(1.08)	(1.08)	(1.94)
$DAHgdp \times dgov$	-0.1615	0.1002	0.8244	-0.5001	0.6964	-0.3961
	(0.63)	(1.59)	(1.07)	(0.57)	(1.38)	(1.08)
	Panel B:	**Polstab**	**As**	**Governance**	**Measure**	
$DAHgdp$	-0.0422**	0.2335**	0.6219**	0.0616**	-0.0064**	-0.5897**
	(2.20)	(1.78)	(2.19)	(2.13)	(1.92)	(1.81)
$DAHgdp \times ddomh$	-0.2466**	0.0094	0.0187**	0.1306**	-0.0261	0.0745
	(2.04)	(0.89)	(1.98)	(1.73)	(0.79)	(0.89)
$DAHgdp \times dgov$	0.0221	0.1978**	-0.0090	0.0419	-0.1172	0.0623
	(0.89)	(1.79)	(0.88)	(1.26)	(0.98)	(0.65)
N	336					

Dependent Variable: Health Outcome

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 5: **DPD Estimates of Health Outcomes: Low and High Healthaid**

Variables	$under5-m$	$TBtreat$	$dpt3-im$	$measles-im$	$chol-im$	$maternal-m$
	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A:	**Low**		**Healthaid**		
$DAHgdp$	-.3235***	0.7168**	0.7745***	0.4462***	-0.1606***	-0.3219**
	(2.08)	(2.23)	(2.01)	(2.85)	(3.02)	(2.70)
$DAHgdp \times ddomh$	-0.0041**	0.0842**	0.0250**	0.7966	-0.0807**	-0.4326**
	(1.92)	(2.18)	(2.10)	(1.14)	(1.89)	(2.01)
$DAHgdp \times dgov$	-0.0526**	0.0821**	-0.2828	0.1836**	-0.0781**	-0.2581
	(1.86)	(1.87)	(1.09)	(2.26)	(2.27)	(1.34)
N 162						
	Panel B:	**High**		**Healthaid**		
$DAHgdp$	-0.9731**	0.0178**	0.3511	-0.1958**	-0.0796**	-0.5998**
	(3.10)	(1.98)	(1.64)	(1.82)	(2.77)	(1.94)
$DAHgdp \times ddomh$	-0.0887**	0.1344	0.3717**	0.7206	0.0261	-0.4378**
	(2.39)	(0.72)	(2.18)	(0.25)	(0.79)	(1.83)
$DAHgdp \times dgov$	-0.1073	0.0082	0.0081	0.0384	-0.0781**	-0.1629**
	(0.78)	(0.70)	(0.80)	(1.61)	(2.27)	(2.33)
N	174					

Dependent Variable: Health Outcome

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$

Table 6: **DPD Estimates of Domestic Heath Expenditures**

Variable	**Coefficient** (2)	**Estimates** (3)
$DAHgdp$	-0.1722**	-0.0024
	(1.78)	(1.11)
$DAHgdp_{t-1}$	0.4759***	0.0043**
	(2.98)	(2.08)
$gdpcap$	-0.0821	0.0043**
	(1.18)	(2.14)
$gdpcapgrow$	0.0039**	0.0062**
	(2.46)	(1.89)
$domh_{t-1}$	0.8212***	0.9249***
	(20.46)	(21.54)
$popgrow$	0.0027	0.0043
	(0.36)	(0.92)
$DAH \times dgov$	0.0502**	0.1236
	(1.86)	(1.18)
$time$	0.0002	-0.0002
	(1.37)	(0.75)
N	336	
F	6131	5622
AR-2 $p-value$	0.346	0.775
Instruments	39	39
Hansen J Statistic	35.26	27.29
$p-value$	0.316	0.632
Hansen C statistic	23.08	11.34
$p-value$	0.234	0.582

Dependent Variable: Domestic Health Expenditure

+ absolute value of "t" statistics in parentheses. * 2-tail significance at $\alpha = 0.10$
** 2-tail significance at $\alpha = 0.05$ *** 2 tail significance at $\alpha = 0.01$