Public financing of health in developing countries: a cross-national systematic analysis

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Summary

Background Government spending on health from domestic sources is an important indicator of a government's commitment to the health of its people, and is essential for the sustainability of health programmes. We aimed to systematically analyse all data sources available for government spending on health in developing countries; describe trends in public financing of health; and test the extent to which they were related to changes in gross domestic product (GDP), government size, HIV prevalence, debt relief, and development assistance for health (DAH) to governmental and non-governmental sectors.

Methods We did a systematic analysis of all data sources available for government expenditures on health as agent (GHE-A) in developing countries, including government reports and databases from WHO and the International Monetary Fund (IMF). GHE-A consists of domestically and externally financed public health expenditures. We assessed the quality of these sources and used multiple imputation to generate a complete sequence of GHE-A. With these data and those for DAH to governments, we estimated government spending on health from domestic sources. We used panel-regression methods to estimate the association between government domestic spending on health and GDP, government size, HIV prevalence, debt relief, and DAH disbursed to governmental and non-governmental sectors. We tested the robustness of our conclusions using various models and subsets of countries.

Findings In all developing countries, public financing of health in constant US$ from domestic sources increased by nearly 100% (IMF 120%; WHO 88%) from 1995 to 2006. Overall, this increase was the product of rising GDP, slight decreases in the share of GDP spent by government, and increases in the share of government spending on health. At the country level, while shares of government expenditures to health increased in many regions, they decreased in many sub-Saharan African countries. The statistical analysis showed that DAH to government had a negative and significant effect on domestic government spending on health such that for every US$1 of DAH to government, government health expenditures from domestic resources were reduced by $0·43 (p=0) to $1·14 (p=0). However, DAH to the non-governmental sector had a positive and significant effect on domestic government health spending. Both results were robust to multiple specifications and subset analyses. Other factors, such as debt relief, had no detectable effect on domestic government health spending.

Interpretation To address the negative effect of DAH on domestic government health spending, we recommend strong standardised monitoring of government health expenditures and government spending in other health-related sectors; establishment of collaborative targets to maintain or increase the share of government expenditures going to health; investment in the capacity of developing countries to effectively receive and use DAH; careful assessment of the risks and benefits of expanded DAH to non-governmental sectors; and investigation of the use of global price subsidies or product transfers as mechanisms for DAH.

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Introduction

The global health community has recognised that public spending on health in developing countries is essential for meeting the Millennium Development Goals, reducing poverty, and fighting major diseases that kill, such as HIV/AIDS, tuberculosis, and malaria.[1–4] As a result, increasing amounts of international aid have been given to health sectors in developing countries. Development assistance for health (DAH) has risen steadily since 1995 from about US$8 billion (constant 2007 $) to nearly $19 billion in 2006.[5] In addition to direct health aid from donors, debt relief to low-income and middle-income countries allows recipient governments to redirect funds from debt servicing to health spending.[6] Certain debt relief

initiatives—the Heavily Indebted Poor Countries and Multilateral Debt Relief initiatives—have conditioned debt relief on spending intended to benefit low-income populations in developing countries, especially government expenditures on health and education.[6–8]

Although these increased flows are important, most public spending on health in developing countries comes from domestic sources. Domestically financed health spending is vital for improving health in these countries,[4] as African leaders acknowledged in Abuja, Nigeria, in 2001, by pledging to devote 15% or more of their yearly budgets to the health sector to fight HIV/AIDS and other infectious diseases.[1] An increase in domestic public financing of health in low-income countries is also suggested to be

crucial for the sustainability of health programmes.[9] The WHO Commission on Macroeconomics and Health recommended that, in addition to urging donors to increase health aid, low-income countries should raise tax revenues by 2% of gross national product by 2015 to finance the health sector.[4] Government spending on health from domestic sources is an important indicator of a government's commitment to the health of its people.

Because of the importance of these funds, tracking public financing for health in developing countries should in theory be simple. Since 1998, the WHO National Health Accounts programme has been reporting public spending on health with a 2–3-year lag.[10,11] The International Monetary Fund (IMF) also tracks public spending on health with a time lag similar to that of WHO.[6] Trends in public financing of health, nevertheless, remain difficult to assess. WHO and IMF track government spending as agent. In principle, this spending includes DAH from government accounts and government health spending from domestic resources.

Alternatively, government as source only includes domestically financed public spending on health. The distinction between government as agent and government as source is not clearly provided in some studies.[12] In addition to this difficulty, WHO is forced to estimate missing data for a substantial proportion of the country years. The actual data and estimates are not always distinguished in the published tables, and detailed information about imputation methods and components is not available to the public.

Results from studies have suggested that a country's gross domestic product (GDP), government size, and external health resources might affect government health financing.[12–17] Understanding the factors that contribute to trends in public financing of health is a sensitive topic, particularly the role of ministries of finance. Whereas ministries of health are committed to increasing the size of health budgets, ministries of finance have at times reduced financing of health in the presence of substantial DAH to government.[15,17,18] The purposes of DAH go beyond relaxing budget constraints in the public sector, and include changing the composition of public expenditures on health and improving the technical quality of those expenditures. That said, if DAH has reduced domestic public expenditures, there might be implications for how DAH is planned and spent through efforts such as the Paris Declaration,[19] the International Health Partnership and Related Initiatives,[20] and others. Fungibility of foreign aid, which occurs when aid substitutes for domestic government spending, has been reported at the aggregate, country, and sector levels.[14,21–25] Cross-country quantitative studies of health-aid fungibility are few and have provided mixed findings, which are hampered by incomplete and low-quality data for health aid and government spending on health.[12,15,17,18]

Enhancement of public financing of health is important for the long-term financial sustainability of the health sector. If donor funding declines or stops, continuation of aid-funded health programmes would be difficult without the financial support of the domestic government. Countries that treat health aid as a substitution for, rather than as an addition to, government health spending might weaken their health systems. Furthermore, households might be forced to pay more from their own pockets and be pushed below the poverty line by catastrophic health payments.[26–31] Reduction of government spending on health from domestic sources in response to DAH is inconsistent with many goals of international donors and domestic policy makers such as the ministries of health.

We therefore did a systematic analysis of all data sources available for government spending on health in developing countries. We used these sources to describe trends in public financing for health, and tested to what extent they are related to changes in GDP, government size, HIV prevalence, debt relief, and DAH to governmental and non-governmental sectors.

Methods

Data sources

Data for government health spending were from data reported to WHO, IMF, and publicly available country reports from ministries of health or finance. WHO published National Health Accounts from 1995 to 2006 for its 193 country members;[10] reported government health expenditures as agent (GHE-A), consisting of tax-funded health expenditures, social security for health, and DAH captured in government accounts;[11] and gathered data from sources such as countries' National Health Accounts reports, budgetary documents, statistical yearbooks, data provided by ministries of health, and other sources.[32] If a country did not report all or some of the components, WHO did the imputations. WHO reported one set of data that combined country-reported values and WHO imputations. The user could not distinguish between data reported by countries and the imputations in the public dataset. On request, WHO helped us identify which values were imputed and which were based on financial reports of countries. Detailed information about the components used to generate imputations was not provided by WHO.

WHO's imputation methods are not standardised, and the imputations were often based on the assumption that the ratio of government health spending to general government spending was constant with time. Since government health spending was one of the essential quantities of interest in this study, use of these ad-hoc and non-standardised imputations would bias the results. We therefore used replicable and standard multiple imputation methods to generate an appropriate dataset. We defined data for a country as reported if 90% of the government health spending was obtained from country reports. For those with more than 10% of GHE-A missing, we coded overall government spending as missing and used multiple imputation methods to estimate them. For 1995–2006, 890 (35%) of 2544 data for GHE-A were missing. In low-income countries, 283 (44%) of 636 were missing.

IMF provided a dataset of GHE-A as a percentage of GDP for countries during 1985–2007. These data were mainly from IMF staff reports, government finance statistics spending outlays, and World Bank public expenditure reviews. 569 (25%) of 2256 data were missing for 1995–2006. In general, IMF values were more likely to represent data from ministries of finance than from ministries of health, and, for some countries, they might not have captured the expenditures of some quasi-governmental organisations. The correlation between the data reported to WHO and IMF was only 0·65, indicating substantial measurement uncertainty in GHE-A.

National sources were obtained for 22 countries directly. Because the data from national sources were not as complete as those from WHO and IMF, we did not use these sources in the analysis presented here. These sources are available on request.
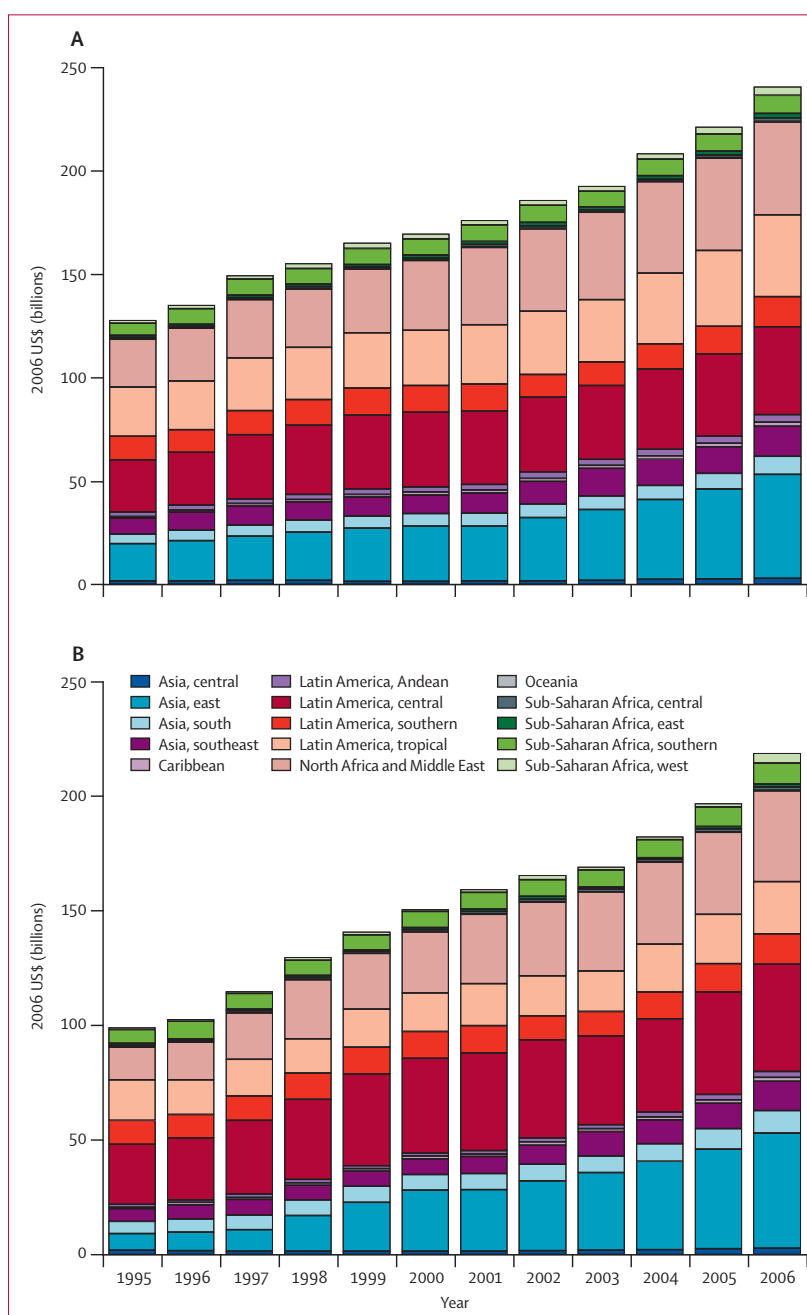

Figure 1: **Government health expenditures as source (GHE-S) from 1995 to 2006 by Global Burden of Disease developing region**
(A) Based on data from WHO, and development assistance for health to government. (B) Based on data from International Monetary Fund, and development assistance for health to government.

Because of the variation with time in the data generated from the databases of WHO and IMF, we assessed medium-term trends to draw conclusions that were robust for all datasets. To do this, we divided 1995–2006 into three periods (1995–98, 1999–2002, and 2003–06) and investigated trends at the regional level in government health spending as source (GHE-S). By definition, the ratio of GHE-S between two periods can be separated
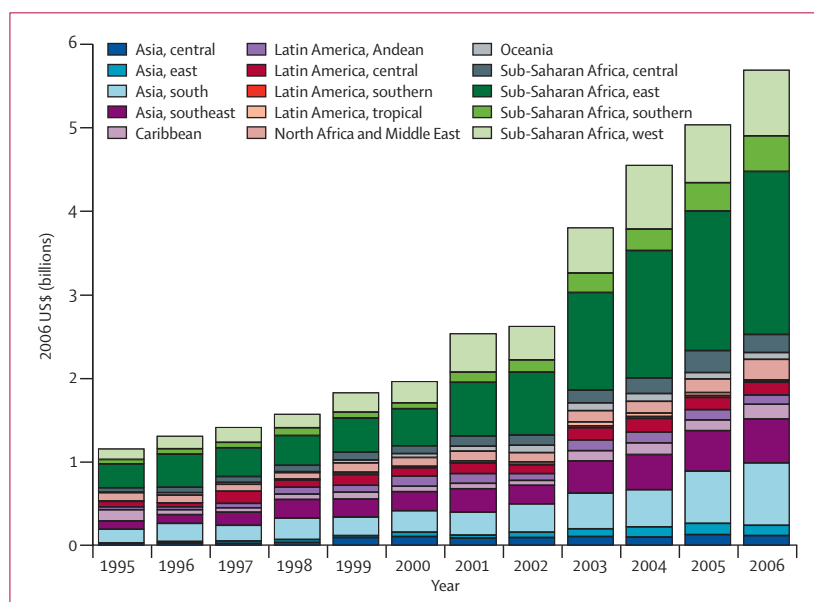
Figure 2: Development assistance for health from 1995 to 2006 by Global Burden of Disease developing region

into the product of three ratios: GDP at time 2 as a fraction of GDP at time 1; general government expenditures (GGE) as a fraction of GDP at time 2 divided by time 1; and the ratio of the fraction of GGE devoted to health (GHE-S/GGE) at the two periods.

Missing data in time-series cross-sectional analysis might produce biased results. For the data from WHO and IMF, we used multiple imputation to generate a coherent time-series cross-sectional dataset for GHE-A.[33–35] We used Amelia II (version 1.2–13.0) to generate 100 imputations for missing GHE-A to GDP ratios in data from IMF and WHO simultaneously.[36–38] We imputed missing values for IMF, and for WHO when the WHO-imputed value was greater than 10% of the WHO-reported GHE-A estimate. As recommended, we included all of our variables in the analysis model, and data from IMF and WHO about their estimates of GGE, and lags and leads of the outcome variables to the third order.[39] Thus, we used all of our data and knowledge to precisely impute missing values in a systematic and replicable manner. In studies in which multiple imputation in health applications was used, predictive validity for time-series cross-sectional data was good.[40] The fully imputed datasets for WHO and IMF are provided in the webappendix (pp 8–13).

For this analysis, we created a new variable, DAH to government, using the database for DAH developed by Ravishankar and colleagues.[5] We identified DAH to government or non-governmental organisations (NGOs) on the basis of detailed project descriptions in the reports of the Organisation for Economic Co-operation and Development's Creditor Reporting System (CRS); development banks; Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM); Global Alliance for

Vaccines and Immunisation (GAVI); US President's Emergency Plan for AIDS Relief; and the Bill & Melinda Gates Foundation. We excluded DAH provided in the form of loans. For disbursements that lacked any information about the channel of delivery, we assumed DAH went to government. To test the sensitivity of our findings to this assumption, we created another variable, DAH unspecified, and included it in the regression analysis. The results are presented in the webappendix (p 6). The findings were consistent with those presented here. To understand the effect of debt relief on government health spending, we created debt relief variables. By use of the CRS database and its sector name Action Relating to Debt, and removal of incremental capitalised interest, we aggregated disbursements and commitments relating to debt forgiveness by country and year. Since debt forgiveness is reported as the lump sum owed to the donor, we assumed an even redistribution of these funds during 10 years. Sensitivity analysis of debt relief was done with two different assumptions—debt relief included capitalised interest or debt relief was evenly redistributed during 5 years (webappendix p 7).

Data sources for other variables are presented in the webappendix (p 1). Descriptive statistics of the variables, and a correlation matrix are also provided in the webappendix (p 1 and p 2, respectively).

Statistical models

We estimated GHE-S by subtracting DAH disbursed to government from GHE-A estimates for each year. We tested the association between government health spending as source and likely determinants, including GDP per person, government size, debt relief, DAH, and the HIV epidemic.[6,12–15,41–44] Because government health spending is reported in local currency units, we used GHE-S as a percentage of GDP as the outcome variable to avoid confounding from the use of deflator and exchange rates. Two sets of outcome variables were obtained from the estimates by IMF and WHO. Our model (panel) was then

$$\left(\frac{GHE-S}{GDP}\right)_{it} = \beta_1\left(\frac{DAH-Gov}{GDP}\right)_{it} + \beta_2\left(\frac{DAH-NonGov}{GDP}\right)_{it}$$

$$+ \beta_3\left(\frac{DR}{GDP}\right)_{it} + \beta_4 GDPpp_{it} + \beta_5\left(\frac{GGE}{GDP}\right)_{it}$$

$$+ \beta_6 HIV_{it} + \mu_i + \varepsilon_{it}$$

We checked for the presence of autocorrelation in each country's time-series data with the Woodridge test. The results of the *F* test showed that the hypothesis of zero correlation between error terms within countries was rejected (p<0·0001). To deal with this issue, we included a lagged dependent variable in the analysis as suggested.[45–47] To counter possible bias resulting from the correlation between DAH to government and

measurement errors in GHE-S, we used the Arellano-Bover/Blundell-Bond (ABBB)[47,48] linear generalised method of moments estimators.[48,49] The ABBB estimator is designed for use with many panels and a few periods; independent variables that are correlated with past and present realisations of the error; fixed effects; and heteroskedasticity and autocorrelation within individual panels.[50] The Arellano-Bond test is done for zero autocorrelation in first-differenced errors, and the output presents no significant evidence of serial correlation in the first-differenced errors at order 2. The test results presented no evidence of incorrect model specification. Use of any model with a lagged dependent variable, such as the ABBB model, tends to under-estimate the coefficients.[47] We applied the equilibrium correction suggested in studies to the estimated coefficients for all regressors.[47,51] To test the sensitivity of our findings from the ABBB model, we also used a fixed-effects model with robust SEs based on the results of the Hausman test.[52] The findings from fixed-effects models are provided in the webappendix (p 4).

The final sample included countries that received health aid and are included in the Global Burden of Disease (GBD) developing regions as defined by the GBD 2005 study (webappendix p 3).[53] Countries with populations of fewer than 150 000 individuals and those where data were too sparse or had reporting errors in GGEs were excluded from the analysis. There were 111 countries in the final analysis (webappendix p 3). All analyses were done in Stata (version 11.0).

Role of the funding source

The funders had no role in study design, data collection and analysis, interpretation of data, decision to publish, or preparation of the report. The corresponding author had full access to all data analysed, and had final responsibility for the decision to submit for publication.

Results

Figure 1 shows the trend in constant 2006 US$ for GHE-S, based on our fully imputed databases of WHO and IMF. In all developing countries, there was a substantial increase in public financing for health from domestic sources—nearly 100% (IMF 120%, WHO 88%) from 1995 to 2006. Figure 1 also shows the trends according to GBD developing regions, with substantial growth in north Africa and the Middle East, Latin America, and especially east Asia (largely in China). The amount of resources committed by governments was much larger than the total DAH in the past 15 years, emphasising the importance of domestic resources. In low-income sub-Saharan Africa, GHE-S increased 242% according to IMF and 132% according to WHO from 1995 to 2006. In the middle-income countries of sub-Saharan Africa, GHE-S increased 78% (IMF) to 92% (WHO) from 1995 to 2006. For all low-income countries,

	GHE-S, WHO	GHE-S, IMF	GHE-S/GGE, WHO	GHE-S/GGE, IMF	GGE/GDP	GDP
Asia						
Central	1·52	1·52	1·15	1·15	0·91	1·44
East	1·52	1·58	1·14	1·18	0·92	1·45
South	1·19	1·20	1·05	1·06	0·88	1·28
Southeast	1·38	1·54	1·07	1·18	1·06	1·23
Caribbean	1·17	1·24	1·03	1·09	0·97	1·18
Latin America						
Andean	1·25	1·47	1·07	1·26	0·98	1·19
Central	1·09	1·02	1·04	0·98	0·94	1·11
Southern	1·03	1·05	1·04	1·05	0·88	1·13
Tropical	1·25	1·20	1·13	1·09	0·98	1·12
North Africa and Middle East	1·24	1·29	1·09	1·13	0·94	1·21
Oceania	0·99	1·03	1·02	1·07	0·91	1·08
Sub-Saharan Africa						
Central	1·16	1·14	0·90	0·89	1·02	1·27
East	1·22	1·05	0·88	0·76	1·15	1·23
Southern	1·02	1·17	0·85	0·97	1·05	1·16
West	1·32	1·52	1·00	1·15	1·01	1·31

Data are shown for developing country regions based on WHO and International Monetary Fund (IMF) databases. Each number is the ratio of that indicator for 2003–06 divided by 1999–2002.

Table 1: **Analysis of trends from 1999–2002 and 2003–06 for government health expenditure as source (GHE-S); share of general government expenditure spent on health (GHE-S/GGE); share of gross domestic product (GDP) spent by government (GGE/GDP); and GDP**

GHE-S increased from $7·96 billion (IMF) to $9·02 billion (WHO) in 1995 to $17·80 billion (IMF) to $18·07 billion (WHO) in 2006. The larger growth according to IMF during this period might be due to incomplete coverage of some parts of government expenditures in earlier years. There were notable differences at the regional and country levels between the data from WHO and IMF that were not accounted for by documentation from either organisation, although the overall trends were roughly consistent.

Figure 2 shows DAH that could be traced directly to the recipient countries in our analysis, increasing from $1·15 billion to $5·69 billion between 1995 and 2006. These sums represented 21% of all DAH in 1995 and 30% of all DAH in 2006. The remainder of DAH represented resources given to organisations, or activities that were regional or global or that could not be traced to specific countries. The most obvious growth in DAH since 1995 was in sub-Saharan African regions, increasing from $0·50 billion in 1995 to nearly $3·40 billion by 2006. Even in low-income sub-Saharan Africa, GHE-S was 2·0 (IMF, $5·90 billion) to 2·3 (WHO, $6·68 billion) times larger in 2006 than the $2·94 billion DAH to government.

Table 1 shows the effect of the three components on GHE-S without any statistical model. The ratios for GDP indicated that even with constant fractions of GDP for health, GDP growth alone in all regions should have led to an increase in GHE-S expenditures. Some regions, such as central Asia, east Asia, and west sub-Saharan
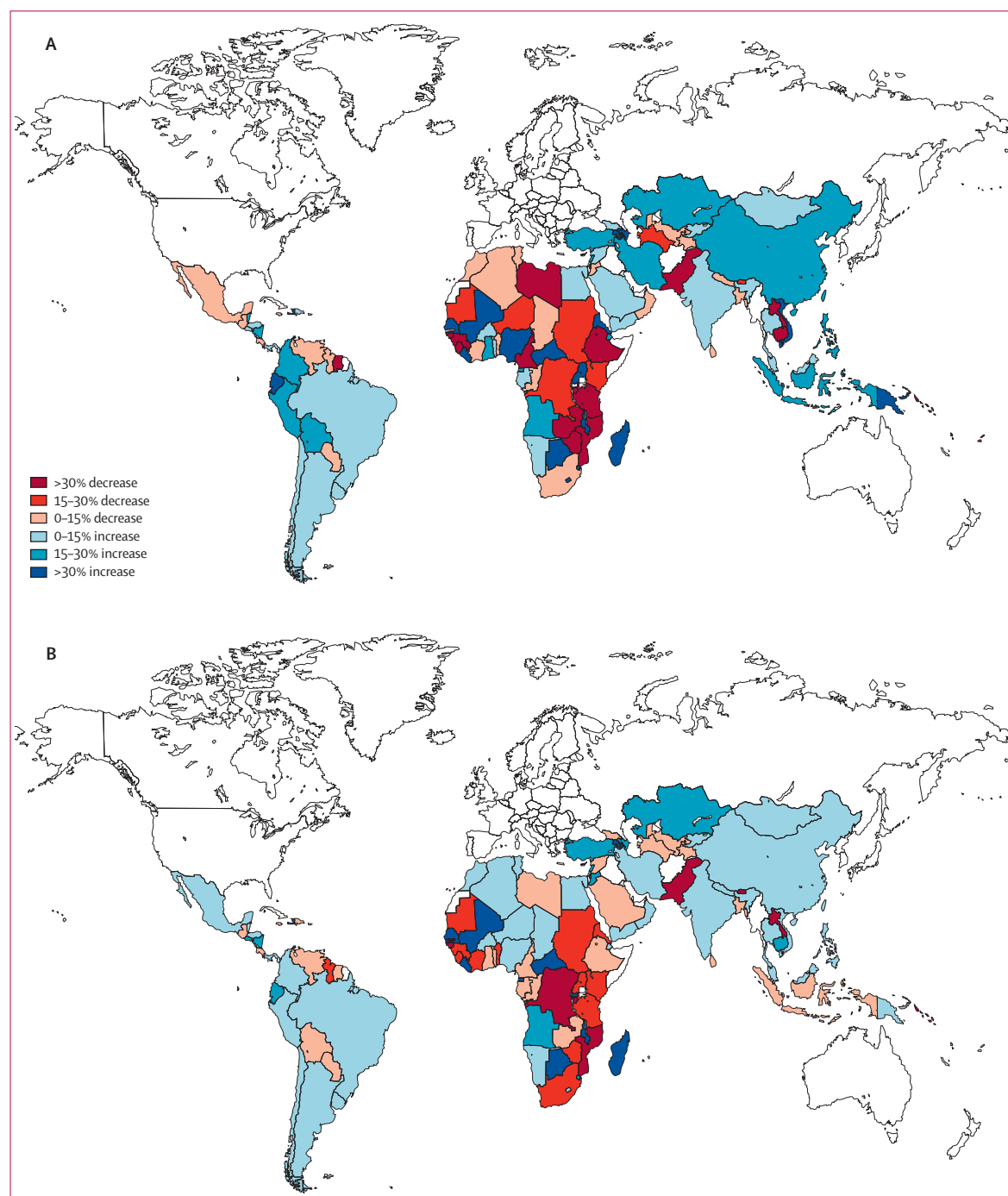
Figure 3: Percentage change in government health expenditure as source as a share of general government expenditure for all countries in Global Burden of Disease developing regions during 1999–2002 compared with 2003–06
(A) International Monetary Fund. (B) WHO.

Africa, had substantial increases in GDP between the two periods, whereas growth in southern Africa has been lower. In all regions except southeast Asia and all of sub-Saharan Africa, the size of government as a share of GDP was reduced—ie, GDP growth was greater than that in government spending.

The most policy-relevant factor to understand is the trend in the fraction of GHE-S as a share of GGE. Although there was variation between the data reported to IMF and WHO, the pattern was quite consistent. Central, east, and southern sub-Saharan Africa were the regions consistently showing decline in GHE-S as the
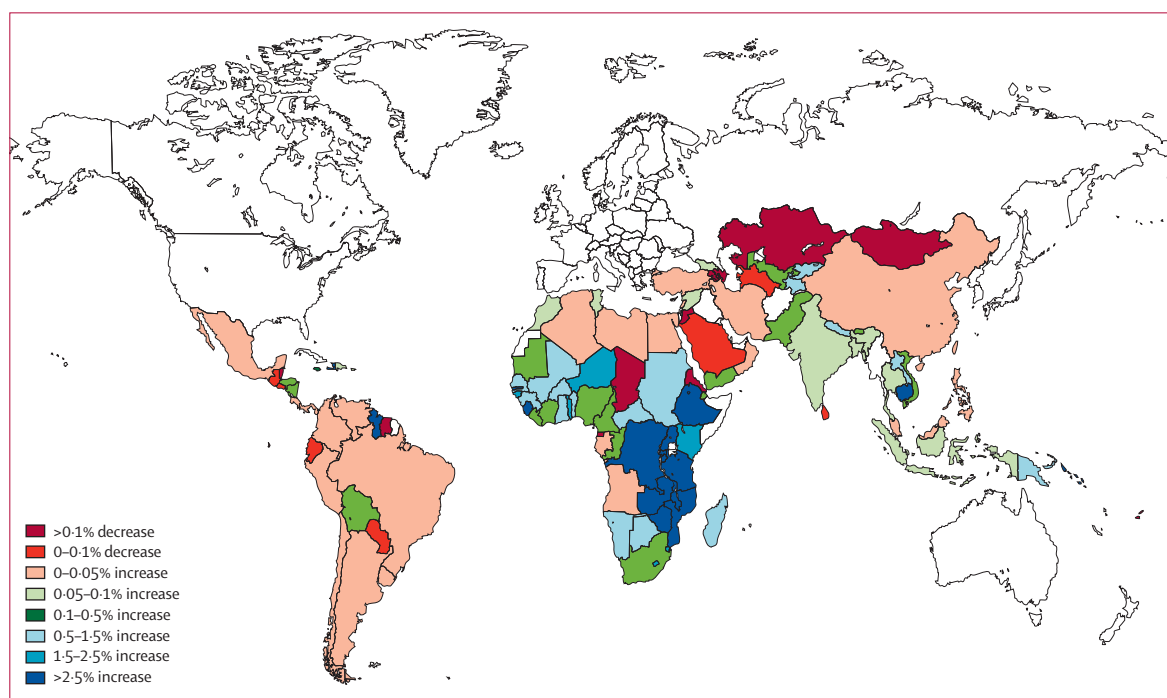
Figure 4: Percentage change in development assistance for health as a share of gross domestic product for all countries in Global Burden of Disease developing regions in 1999–2002 compared with 2003–06

share of GGE, and east and southern sub-Saharan Africa were the regions where governments had received the largest amount of DAH.

Figure 3A shows the ratio of the fraction of GGE spent on health during 2003–06 compared with during 1999–2002 by country according to IMF. Figure 3B shows the same information according to WHO. There was substantial variation even within regions in the trends in government commitment to the health sector. There were also notable differences at the country level between the databases of IMF and WHO, yet the overall pattern remained similar. Large parts of Latin America, the Middle East, and Asia showed increasing government commitment to health, whereas many but not all countries in sub-Saharan Africa showed decreasing commitment. The largest reductions in the fraction of GHE-S were noted for parts of sub-Saharan Africa with the largest HIV epidemics and also the largest contributions of DAH to government. Figure 4 shows the change in DAH as a fraction of GDP for the same periods.

The results of the analysis of the databases of WHO and IMF were remarkably consistent even if the data varied substantially by country and year (table 2). Three variables that might be related to GHE-S—HIV seroprevalence, GDP per person, and debt relief—had no significant association in these analyses.[6,12,14–16,41–44] Although we might have expected a large HIV epidemic to induce governments to increase their spending on health, there was no evidence to suggest that this effect occurred. We

also tested models in which we used a 3-year lag on HIV seroprevalence, and these also showed no association. Debt relief in principle should have led to an increase in GHE-S,[6,43] because much of it was meant to increase spending on poor people, but there was no evidence to support this effect. In the datasets of IMF and WHO, the coefficients for the share of GDP spent by government were significant, suggesting that, with other things constant, as government spending increased, 2–6% of the increase went to the health sector.

The DAH to government as a share of GDP coefficients showed a significant negative effect on GHE-S as a share of GDP. For all developing countries in the WHO dataset, the coefficient suggested that for every $1 of DAH to government, the government reduced spending from its own sources by $0·46 (95% CI 0·67–0·24; table 2). The results with the IMF database were nearly identical. This estimate was probably underestimated with the ABBB model, and the equilibrium-corrected coefficients suggested much greater fungibility: it is possible that every $1 of DAH to government might lead to a reduction of $1 or more in domestic government health spending. Regression results from alternative estimation methods presented in the webappendix were similar (p 4). The coefficients of DAH to government from subgroup analyses for low-income and lower-middle-income countries, low-income countries, and sub-Saharan Africa were consistent with the findings presented here. The regression results for the subgroup analyses are presented in the webappendix (p 5).

	DAH to government/ GDP (SE)	p value	DAH to non-government/GDP (SE)	p value	Debt relief/GDP (SE)	p value	GDP per person (SE)	p value	GGE/GDP (SE)	p value	HIV prevalence (SE)	p value
Coefficients												
WHO	−0·46 (0·11)	0	0·69 (0·15)	0	0·05 (0·04)	0·161	$-2 \cdot 55 \times 10^{-7}$ $(2 \cdot 28 \times 10^{-7})$	0·264	0·03 (0·01)	0·009	0·04 (0·03)	0·171
IMF	−0·43 (0·09)	0	0·58 (0·15)	0	−0·01 (0·03)	0·750	$-2 \cdot 66 \times 10^{-7}$ $(2 \cdot 78 \times 10^{-7})$	0·338	0·02 (0·01)	0·021	0·03 (0·03)	0·283
Equilibrium-corrected coefficients												
WHO	−1·14 (0·27)	0	1·72 (0·38)	0	0·13 (0·09)	0·161	$-6 \cdot 33 \times 10^{-7}$ $(5 \cdot 66 \times 10^{-7})$	0·264	0·06 (0·02)	0·009	0·10 (0·08)	0·171
IMF	−1·01 (0·21)	0	1·36 (0·34)	0	−0·02 (0·07)	0·750	$-6 \cdot 23 \times 10^{-7}$ $(6 \cdot 51 \times 10^{-7})$	0·338	0·05 (0·02)	0·021	0·07 (0·06)	0·283

Results are based on an analysis of the databases of WHO and International Monetary Fund (IMF). DAH=development assistance for health. GGE=general government expenditure.

Table 2: Time-series cross-sectional regression results for government health expenditure as source (GHE-S) as a share of gross domestic product (GDP) for countries in Global Burden of Disease developing regions based on the Arellano-Bover/Blundell-Bond model

DAH to NGOs had a coefficient ranging from 0·58 to 1·72 in the different models, and all of them were significant at p=0. The positive and significant coefficients in all models suggested that DAH to NGOs and other private organisations led governments to increase allocation of domestic resources to the health sector. These results were also robust in alternative estimation methods (webappendix p 4) and subgroup analyses (webappendix p 5).

Table 3 shows the subanalyses for low-income countries, low-income and lower-middle-income countries, and countries in sub-Saharan Africa. The association between GHE-S and DAH to government and DAH to non-governmental entities was consistent in low-income countries, and low-income and lower-middle-income countries. Further, the magnitude of the effect and significance were similar. Results of an analysis restricted to sub-Saharan African countries also showed the same degree of additionality (table 3), which was the extent to which DAH supplemented GHE-S, as for low-income and low-middle income-countries combined.

Discussion

For low-income and middle-income countries in most regions of the world, GHE-S is increasing in absolute terms. DAH is a key factor leading to a decline in government spending on health from domestic sources in some countries. The increase in GHE-S is not simply due to increases in GDP but is also attributed to rising GGE devoted to health, even as overall size of the government in most regions is shrinking. If this trend continues, we can expect that the share of GDP spent by governments on health will tend to increase, leading to expanded health programmes financed through government-mediated risk-pooling. Increases in the share of government spending on health are likely to occur slowly with time. In those countries where GHE-S as a share of GGE does not increase, incremental growth might take many years to catch up with other countries

where increases have occurred steadily. Increased understanding of factors that might be adversely affecting the share of GGE committed to health and undermining the sustainability of the health sector, such as DAH to government, is needed.

Ministries of finance tend to reduce funding to ministries of health and other government ministries that spend money on health when large amounts of DAH are given to government. The formal statistical analysis is consistent with this finding for the various data sources. On average, for every $1 of DAH given to government, the ministry of finance reduces the amount of government expenditures allocated to the ministry of health and other government agencies that engage in health spending by about $0·43 to $1·14. From the global health community's perspective, this means that to increase government health spending by $1, global health funders need to provide at least $1·75 of DAH. For an initiative such as the High-Level Taskforce on Innovative International Financing for Health Systems, which asked for $30 billion to save the lives of 10 million mothers and children in developing countries, funders would need to spend at least $53 billion if those funds were channelled through governments.[3] If the higher estimates of fungibility are accurate, even larger sums might be required to increase net government health spending.

The limitations of our study were largely a result of continued challenges in the data for GHE-A, DAH to government, and DAH to NGOs, and, by inference, GHE-S. Even with careful assessment of available project-level databases, we suspect that estimates of DAH to government and DAH to the non-governmental sector are probably incomplete. This analysis did not provide any indication of the mechanism by which DAH to NGOs could increase government commitment to health. At the very least, we should interpret these results as suggesting that government behaviour in terms of expenditures seems to be fundamentally different for DAH to

government and DAH to NGOs. Of $19 billion in DAH disbursed in 2006, we were only able to trace $5·7 billion to GBD developing regions—ie, DAH might be underestimated, which implies that GHE-S could be lower than reported here. If true, the trend in GHE-S would be less favourable than reported here, and also reduce the additionality of DAH to government below the levels estimated here. Improved information about the trends in and distribution of the untraceable DAH could alter the findings presented here. The highly consistent findings in the subgroups of countries suggest that the average rate of additionality for DAH to government and the effect of DAH to NGOs are robust for many types of countries. Nevertheless, within each block of countries, there is likely to be substantial heterogeneity in the degree of additionality (figure 3; figure 4). Further, the inconsistencies in the databases from IMF, WHO, and country-reported data indicate variation in reporting and inconsistent information produced by ministries of finance and health. Although in principle, governments report their spending as agent, including DAH, there might be substantial variation in the application of these accounting principles. Some governments might incorrectly report GHE-S as GHE-A, but further studies are needed to understand if such reporting occurs on a substantial scale. Despite these data limitations, the consistency of the results between the databases of IMF and WHO, and the similarity of findings in the many subgroup analyses we have examined suggest that the overall conclusions might be robust, but that we should not draw strong conclusions for any one country. Another limitation is that symmetry was assumed in the models used in these analyses—ie, the effect of an increase in DAH is the reverse of the effect of a decline in DAH. This limitation is unlikely to affect results, however, since most of the countries in the model have had rising DAH because of its massive scale-up during the study.

Many development economists might view these findings as evidence of rational behaviour on the part of ministries of finance, whereas some in the global health community might be surprised. Reactions depend on the perspective taken and on the objectives of DAH. In addition to increasing the level of public spending on health, DAH might seek to alter the composition of such spending across diseases or delivery platforms, or to help the introduction of new technologies or modes of delivery. Although a major objective of DAH is to increase public spending on health, an important question is whether the subadditionality of DAH to government, which occurs when ministries of finance reduce domestic health spending in response to receiving DAH, increases or decreases overall social welfare? To answer that question, we would need to know on what the resources taken from the budgets of ministries of health are spent. These funds could be going to education, infrastructure development, poverty alleviation, or various other underfinanced programmes that improve health. Or they could be funding the military, industrial development, or

	DAH to government/ GDP (SE)	p value	DAH to non-government/GDP (SE)	p value
Low-income and lower-middle-income countries (n=87)				
Coefficients				
WHO	−0·41 (0·09)	0	0·68 (0·17)	0
IMF	−0·40 (0·09)	0	0·60 (0·15)	0
Equilibrium-corrected coefficients				
WHO	−1·08 (0·24)	0	1·78 (0·45)	0
IMF	−0·92 (0·21)	0	1·38 (0·35)	0
Low-income countries (n=46)				
Coefficients				
WHO	−0·35 (0·10)	0	0·75 (0·18)	0
IMF	−0·32 (0·09)	0·001	0·47 (0·15)	0·002
Equilibrium-corrected coefficients				
WHO	−0·92 (0·26)	0	1·98 (0·48)	0
IMF	−0·78 (0·22)	0·001	1·15 (0·37)	0·002
Sub-Saharan African countries (n=42)				
Coefficients				
WHO	−0·26 (0·13)	0·055	0·59 (0·18)	0·001
IMF	−0·34 (0·11)	0·002	0·44 (0·15)	0·004
Equilibrium-corrected coefficients				
WHO	−0·80 (0·40)	0·055	1·82 (0·56)	0·001
IMF	−0·86 (0·28)	0·002	1·11 (0·38)	0·004

Results are based on an analysis of the databases of WHO and International Monetary Fund (IMF). DAH=development assistance for health.

Table 3: **Time-series cross-sectional regression results for government health expenditure as source (GHE-S) as a share of gross domestic product (GDP) for subgroups of countries based on the Arellano-Bover/Blundell-Bond model**

other programmes with unknown health effects. Furthermore, governments could be using DAH to increase government financial reserves. With the weaknesses in public finance data, there is no near-term prospect of quantifying the overall effect of the subadditionality of DAH on social welfare. Further, in reducing GHE-S, ministries of finance might not simply be pursuing domestic priorities. The motivations of ministries of finance might be external—eg, caused by loan conditions imposed by global financial institutions.[54–57] Case studies could help elucidate the complex dynamics behind these findings, although our efforts to investigate these findings in detail in Zambia and Malawi showed substantial local uncertainty about the actual financial flows. As a part of this effort, detailed, comprehensive, and reliable data should be gathered.

Donors funding specific programmes to fight diseases such as HIV/AIDS, malaria, or tuberculosis pay attention to spending on these programmes,[58–60] and the purposes of these types of DAH might be as much to reallocate health spending and to increase its technical quality as to increase overall spending. From the perspective of the ministries of health, however, cuts by ministries of finance in the budgets of the ministries of health need to come from somewhere—if not donor-targeted programmes, then most probably from reduced investment and

maintenance of primary care, district hospital infrastructure, and human resource development. Ministries of health are seldom in a powerful position to defend their budgets with ministries of finance, particularly amid massive inflows of DAH. We know that the share of government expenditures going to health is declining in some countries, but the state of data for public expenditure is not sufficient to define which components are decreasing.

The effect of DAH to government on GHE-S might be difficult from the perspectives of health donors. Even if the behaviour of the ministries of finance enhanced welfare, the subadditionality of DAH to government could jeopardise the accountability of donors to their parliaments and citizens. Additionality has long been a concern, and is a founding principle of GFATM.[61,62] Persuasion of parliaments and the US Congress to fund enhanced health programmes in low-income and middle-income countries might be difficult if DAH does not lead to greater health spending.

An additional reason for subadditionality might be attributed to the inability of some countries to fully receive or use DAH.[63] Ministries might lack the required managerial, supervisory, or leadership capacities to scale-up activities rapidly. To the extent that lack of absorptive capacity is leading to subadditionality, appropriate responses will depend on a long-term perspective that includes investments in strengthening capacity and in careful monitoring.

Because we believe that sustaining and increasing funding for health is crucial to improving health in the developing world, we make five recommendations. These recommendations should, if implemented, provide the basis for accountability and transparent dialogue about competing national priorities.

First, adopt a clear set of reporting standards for GHE-S and spending in other health-related sectors. Because of the importance of domestically financed public funding of health programmes in low-income and middle-income countries, of great concern is that the global community has put little emphasis on comparable and consistent reporting by ministries of finance or the appropriate component of government on GHE-S. The incompleteness and inconsistency between IMF and WHO data for GHE-A is in contrast with the collective efforts to track national accounts and other important macro-economic indicators. Despite these inconsistencies in data, however, there is evidence of divergent trends across low-income and middle-income countries in GHE-S. Improved assessment and understanding of these important trends must be a priority in the future.

Debates at the country level will continue as long as there are substantially different data produced by WHO, IMF, ministries of finance, and ministries of health. Governments, however, can know what they spend from their own sources for health. Although various countries might have different accounting traditions,[64] the success of standardising the System of National Accounts indicates that promulgation of clear standards, such as those embodied in the Organisation for Economic Co-operation and Development's System of Health Accounts, is feasible.[65,66] Leading funders in global health, such as the UK, the USA, GFATM, GAVI Alliance, and World Bank, should encourage ministries of finance to report GHE-S in a transparent way as part of receiving DAH. Substantial capacity-building support for strengthening management of public expenditure in developing countries is also essential for improvement of transparency.[67] Although transparency would not ensure additionality, it would be the foundation for dialogue between donors, ministries of health, and ministries of finance. The development of global standards for reporting GHE-S should involve consensus building from all nations. The global health community should also prioritise transparent, comparable reporting of domestically financed spending in other sectors that can improve population health, such as education, and water and sanitation.

The burden of transparency also extends to high-income countries and donors. High-income countries should also report GHE-S. Because of the serious issues of data quality of DAH, donors should report DAH transparently.

Second, collaborative targets should be set to maintain or increase GHE-S as a share of GGE. One step beyond transparency would be for donors to work with ministries of finance and health to establish clear targets to increase GHE-S as a share of GGE before disbursement of DAH. International Health Partnership and Related Initiatives or other initiatives would provide a mechanism to assist this discussion. If reallocation of resources within the health sector is an objective of DAH, donors might also through this negotiation advocate for an increasing share of high-productivity parts of public spending, such as disease control, primary care, and district hospitals. For this reallocation to be effective, global financial institutions also must commit to encouraging sustained or enhanced GHE-S in low-income and middle-income countries. Encouragement of a clear understanding of the trajectory for GHE-S as a share of GGE between donors, ministries of finance, and ministries of health is urgently needed. Although this share is increasing in most countries, every year that it remains constant or declines is potentially a lost opportunity in terms of the magnitude of health funding in the mid to long term. Even if DAH to government leads ministries of finance to reduce GHE-S as a share of GGE, the association might not be symmetrical: if DAH to government declines, ministries of finance might not respond by increasing GHE-S as a share of GGE. Paradoxically, in 5 years or 10 years, countries that received large amounts of DAH but did not steadily increase GHE-S as a share of GGE might end up having low public expenditures on health.

Third, we should invest in the absorptive capacity of ministries of health. The donor community should assess

the extent to which the lack of implementation capacity leads to subadditionality in the health sector. Such a case-by-case assessment also would help improve understanding within each recipient country of the key factors that contribute to declining shares of government expenditures devoted to health. In settings where lack of capacity is a major constraint, DAH should finance expansion of this capacity.

Fourth, the risks and benefits of expanded DAH to non-governmental sectors should be carefully assessed. An unexpected finding in this analysis is that DAH through NGOs might be fully additional. In some models, this form of DAH might lead to increases in GHE-S as a share of GGE. Should donors follow the lead of the US government and channel an increasing share of DAH through NGOs? From a purely health expenditure perspective, the answer might be yes, but the effectiveness of NGOs should first be explored cautiously before rerouting DAH from governments to NGOs. What is the effect of NGOs paying higher wages to local staff on their efficiency and the local market salary for health workers? DAH to NGOs might increase GHE-S through upward pressure on wages and other input prices in the local markets.[68,69] Do these organisations actually deliver services to the rural and urban poor? If NGOs are as efficient as government in producing services and are not simply delivering services to the urban middle class, then they might be a very good buy indeed. If ministries of finance find it difficult to reduce budgets of the ministries of health when funds go through private channels, then a coordination mechanism whereby increased integration of NGO activities into an overall health strategic plan might provide mechanisms for enhanced additionality and health-system strengthening. The risks and benefits of channelling DAH through NGOs should be carefully assessed. The extraordinary paucity of information about country-level expenditures, and efficiency of NGOs and other private organisations in developing countries, restricts our ability to understand whether negative externalities of NGOs are occurring. Further studies are needed to assess the effect of aid delivered by NGOs, and NGOs need to provide transparent country-level expenditure data to make these studies possible.

Fifth, the use of global price subsidies or global purchasing of drugs, vaccines, and supplies should be investigated. One strategy to enhance the additionality of DAH could be to change the prices that governments pay rather than routing funds through their accounts. Mechanisms such as the Affordable Medicines Facility–malaria,[70] or the purchasing and delivery of supplies to countries that are off-budget but enhance their purchasing power might not be subject to changes by ministries of finance in GHE-S. This recommendation is speculative since there is no direct evidence on how behaviour of ministries of finance will change in response to these mechanisms. At the very least, they should be given

greater consideration in light of substantial sub-additionality in DAH to government.

In preparing this study, we were concerned that the finding that DAH to government is subadditional could be used by sceptics of development assistance to justify reductions in funding. A response to this concern could be to suppress these findings. For three reasons, we believe that these results warrant broad scientific and policy debate. First, a core principle of science is to follow the evidence and not publish selectively. Second, there are firm actions that can be taken to enhance the general trend toward increasing budgets for health even in the presence of major inflows of DAH. Third, addressing subadditionality in the health sector can in the near term lead to improved understanding of the issue, and policy changes to ensure future increases in public financing of health. Because funding for health can improve the lives of millions of poor people in developing countries, these actions are a moral imperative.

References
1   UN. African summit on HIV/AIDS, tuberculosis and other related infectious diseases: Abuja declaration on HIV/AIDS, tuberculosis, and other infectious diseases. New York: United Nations, 2001. http://www.un.org/ga/aids/pdf/abuja_declaration.pdf (accessed Dec 17, 2009).
2   UN. Report of the International Conference on Financing for Development. New York: United Nations, 2002. http://www.un.org/esa/ffd/doha/documents.htm (accessed Dec 30, 2009).
3   IHP. High Level Taskforce on Innovative International Financing for Health Systems: terms of reference and management arrangements. New York: International Health Partnership, 2008. http://www.internationalhealthpartnership.net/pdf/IHP%20Update%2013/Taskforce/TF%20REVISED%20Press%20statement%20(2008%2011%2030)%20v%206.pdf (accessed Dec 17, 2009).
4   WHO. WHO Commission on Macroeconomics and Health. Macroeconomics and health: investing in health for economic development. Geneva: World Health Organization, 2001. http://whqlibdoc.who.int/publications/2001/924154550x.pdf (accessed Dec 17, 2009).
5   Ravishankar N, Gubbins P, Cooley RJ, et al. Financing of global health: tracking development assistance for health from 1990 to 2007. *Lancet* 2009; **373**: 2113–24.

6	Gupta S, Clements B, Guin-Siu MT, Leruth L. Debt relief and public health spending in heavily indebted poor countries. *Bull World Health Organ* 2002; **80:** 151–57.

7	IMF. Debt relief under the Heavily Indebted Poor Countries (HIPC) Initiative. Washington DC: International Monetary Fund, 2009. http://www.imf.org/external/np/exr/facts/hipc.htm (accessed Dec 17, 2009).

8	IMF. The Multilateral Debt Relief Initiative (MDRI). Washington DC: International Monetary Fund, 2009. http://imf.org/external/np/exr/facts/mdri.htm (accessed Dec 17, 2009).

9	Heller PS. Understanding fiscal space. Washington DC: International Monetary Fund, 2005. https://www.imf.org/external/pubs/ft/pdp/2005/pdp04.pdf (accessed Dec 17, 2009).

10	WHO. National health accounts. Geneva: World Health Organization, 2009. http://www.who.int/nha/country/en/ (accessed Dec 17, 2009).

11	Poullier JP, Hernandez P, Kawabata K. National health accounts: concepts, data sources and methodology. Geneva: World Health Organization, 2002. http://www.who.int/healthinfo/paper47.pdf (accessed Dec 17, 2009).

12	Mishra P, Newhouse D. Health aid and infant mortality. Washington DC: International Monetary Fund, 2007. http://www.imf.org/external/pubs/ft/wp/2007/wp07100.pdf (accessed Dec 17, 2009).

13	Baldacci E, Clements B, Gupta S, Cui Q. Social spending, human capital, and growth in developing countries. *World Dev* 2008; **36:** 1317–41.

14	Devarajan S, Rajkumar AS, Swaroop V. What does aid to Africa finance? Washington DC: World Bank, 1999. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/1999/08/15/000094946_9904020601437/additional/280868028_20050283051934.pdf (accessed Dec 17, 2009).

15	Farag M, Nandakumar AK, Wallack SS, Gaumer G, Hodgkin D. Does funding from donors displace government spending for health in developing countries? *Health Aff* 2009; **28:** 1045–55.

16	Musgrove P, Zeramdini R, Carrin G. Basic patterns in national health expenditure. *Bull World Health Organ* 2002; **80:** 134–46.

17	Yontcheva B, Masud N. Does foreign aid reduce poverty? Empirical evidence from nongovernmental and bilateral aid. Washington DC: International Monetary Fund, 2005. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=887969 (accessed Dec 17, 2009).

18	Gottret PE, Schieber G. Health financing revisited: a practitioner's guide. Washington DC: World Bank, 2006. http://siteresources.worldbank.org/INTHSD/Resources/topics/Health-Financing/HFRFull.pdf (accessed Dec 17, 2009).

19	Paris Declaration on Aid Effectiveness: ownership, harmonisation, alignment, results, and mutual accountability. Paris: High Level Forum, 2005. http://siteresources.worldbank.org/ACCRAEXT/Resources/4700790-1210698244754/Paris-Declaration.pdf (accessed Mar 23, 2010).

20	IHP + RI. About IHP+. Geneva: International Health Partnership + Related Initiatives, 2009. http://www.internationalhealthpartnership.net/en/home (accessed Dec 17, 2009).

21	Feyzioglu T, Swaroop V, Zhu M. A panel data analysis of the fungibility of foreign aid. *World Bank Econ Rev* 1998; **12:** 29–58.

22	Heller PS. A model of public fiscal behavior in developing countries: Aid, investment, and taxation. *Am Econ Rev* 1975; **65:** 429–45.

23	Pack H, Pack JR. Foreign aid and the question of fungibility. *Rev Econ Stat* 1993; **75:** 258–65.

24	Pettersson J. Foreign sectoral aid fungibility, growth and poverty reduction. *J Int Dev* 2007; **19:** 1074–98.

25	Swaroop V, Jha S, Sunil Rajkumar A. Fiscal effects of foreign aid in a federal system of governance: the case of India. *J Public Econ* 2000; **77:** 307–30.

26	van Doorslaer E, O'Donnell O, Rannan-Eliya RP, et al. Effect of payments for health care on poverty estimates in 11 countries in Asia: an analysis of household survey data. *Lancet* 2006; **368:** 1357–64.

27	Wagstaff A, van Doorslaer E. Catastrophe and impoverishment in paying for health care: with applications to Vietnam 1993–1998. *Health Econ* 2003; **12:** 921–34.

28	WHO. The world health report 2000–health systems: improving performance. Geneva: World Health Organization, 2000. http://www.who.int/whr/2000/en/ (accessed Dec 17, 2009).

29	Xu K, Klavus J, Kawabata K, et al. Household health system contributions and capacity to pay: definitional, empirical and technical challenges. In: Murray CJL, Evans DB, eds. Health systems performance assessment: debates, methods and empiricism. Geneva: World Health Organization, 2003: 533–42.

30	Xu K, Klavus J, Aguilar-Rivera AM, Carrin G, Zeramdini R, Murray CJL. Summary measures of the distribution of household financial contributions to health. In: Murray CJL, Evans DB, eds. Health systems performance assessment: debates, methods and empiricism. Geneva: World Health Organization, 2003: 543–55.

31	Xu K, Evans DB, Kawabata K, Zeramdini R, Klavus J, Murray CJL. Household catastrophic health expenditure: a multicountry analysis. *Lancet* 2003; **362:** 111–17.

32	WHO. Explanatory notes. Geneva: World Health Organization, 2009. http://www.who.int/nha/country/Explanatory%20-%20annex%20notes.pdf (accessed Dec 17, 2009).

33	Horton NJ, Kleinman KP. Much ado about nothing: a comparison of missing data methods and software to fit incomplete data regression models. *Am Stat* 2007; **61:** 79–90.

34	Little RJA, Rubin DB. Statistical analysis with missing data. Hoboken: Wiley-Interscience, 2002.

35	Rubin DB. Multiple imputation for nonresponse in surveys. Hoboken: Wiley-Interscience, 2004.

36	Honaker J, King G. What to do about missing values in time series cross-sectional data. http://gking.harvard.edu/files/pr.pdf (accessed Dec 30, 2009).

37	King G, Honaker J, Joseph A, Scheve K. Analyzing incomplete political science data: an alternative algorithm for multiple imputation. *Am Polit Sci Rev* 2001; **95:** 49–69.

38	Honaker J, King G, Blackwell M. Amelia II. http://gking.harvard.edu/amelia/ (accessed Jan 20, 2010).

39	Honaker J, King G, Blackwell M. Amelia II: a program for missing data. http://gking.harvard.edu/amelia/docs/amelia.pdf (accessed Jan 20, 2010).

40	Lim S S, Stein D B, Charrow A, Murray CJL. Tracking progress towards universal childhood immunisation and the impact of global initiatives: a systematic analysis of three-dose diphtheria, tetanus, and pertussis immunisation coverage. *Lancet* 2008; **372:** 2031–46.

41	Arndt C, Lewis JD. The macro implications of HIV/AIDS in South Africa: a preliminary assessment. *S Afr J Econ* 2000; **68:** 856–87.

42	Haacker M. The impact of HIV/AIDS on government finance and public services. In: Haacker M, ed. The macroeconomics of HIV/AIDS. Washington, DC: International Monetary Fund, 2004: 198–258.

43	Kaddar M, Furrer E. Are current debt relief initiatives an option for scaling up health financing in beneficiary countries? *Bull World Health Organ* 2008; **86:** 877–83.

44	Stover J, Bollinger L. The economic impact of AIDS. Washington DC: The Futures Group International, 1999. http://www.policyproject.com/pubs/SEImpact/SEImpact_Africa.pdf (accessed Dec 17, 2009).

45	Beck N, Katz JN. What to do (and not to do) with time-series cross-section data. *Am Polit Sci Rev* 1995; **89:** 634–47.

46	Beck N, Katz JN. Nuisance vs substance: specifying and estimating time-series-cross-section models. *Polit Anal* 1996; **6:** 1–36.

47	Keele L, Kelly NJ. Dynamic models for dynamic theories: the ins and outs of lagged dependent variables. *Polit Anal* 2006; **14:** 186–205.

48	Arellano M, Bover O. Another look at the instrumental variables estimation of error components models. *J Econom* 1995; **68:** 29–51.

49	Blundell R, Bond S. Initial conditions and moment restrictions in dynamic panel data models. *J Econom* 1998; **87:** 115–43.

50	Roodman D. How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata J* 2009; **9:** 86–136.

51	Pesaran MH, Smith R. Estimating long-run relationships from dynamic heterogeneous panels. *J Econom* 1995; **68:** 79–113.

52	Kristensen IP, Wawro G. Lagging the dog? The robustness of panel corrected standard errors in the presence of serial correlation and observation specific effects. http://polmeth.wustl.edu/retrieve.php?id=54 (accessed Dec 30, 2009).

53 Murray CJ, Laakso T, Shibuya K, Hill K, Lopez AD. Can we achieve Millennium Development Goal 4? New analysis of country trends and forecasts of under-5 mortality to 2015. *Lancet* 2007; **370:** 1040–54.

54 De Renzio P, Goldsbrough D. IMF programs and health spending: Case study of Mozambique. Washington DC: Center for Global Development, 2007. http://www.cgdev.org/doc/IMF/Mozambique. pdf (accessed Dec 17, 2009).

55 Ooms G, Schrecker T. Expenditure ceilings, multilateral financial institutions, and the health of poor populations. *Lancet* 2005; **365:** 1821–23.

56 Structural Adjustment Participatory Review International Network. The policy roots of economic crisis and poverty: a multi-country participatory assessment of structural adjustment. Executive summary. Washington, DC: Structural Adjustment Participatory Review International Network, 2002. http://www.saprin.org/ SAPRI_Findings.pdf (accessed Dec 17, 2009).

57 Vujicic, M, Ohiri, K, Sparkes S. Working in health: financing and managing the public sector health workforce. Washington, DC: World Bank, 2009. http://web.worldbank.org/WBSITE/EXTERNAL/ TOPICS/EXTHEALTHNUTRITIONANDPOPULATION/EXTHSD/0 ,,contentMDK:22205903~pagePK:148956~piPK:216618~theSiteP K:376793,00.html (accessed Dec 17, 2009).

58 GFATM. Report of the Portfolio Management and Procurement Committee (PMPC). Geneva: The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2003. http://www.theglobalfund.org/ documents/board/06/gfb69.pdf (accessed Dec 17, 2009).

59 GAVI Alliance. Programme and Policy Committee (PPC) Meeting. Geneva: GAVI Alliance, 2009. http://gavistg3.elca-services.com/ resources/Final_Report_of_PPC_Meeting_15_16_April_2009.pdf (accessed Dec 17, 2009).

60 De S, Dmytraczenko T. National resource flows for HIV/AIDS in Kenya, Rwanda, and Zambia: a comparative analysis. Bethesda: Abt Associates, 2006. http://pdf.usaid.gov/pdf_docs/PNADH207.pdf (accessed Dec 14, 2009).

61 Post S, McGreevey W. Additionality: dimensions, issues and indicators. Measuring the systems effects of the global fund with a focus on additionality, partnerships, and sustainability. Geneva: The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2005: 13–29. http://www.theglobalfund.org/documents/me/MSE_en.pdf (accessed Dec 17, 2009).

62 GFATM. Global fund annual report 2005. Geneva: The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2005. http://www. theglobalfund.org/documents/publications/annualreports/ 2005/2005_Annual_Report_lowres.pdf (accessed Dec 14, 2009).

63 Clemens M, Radelet S. Absorptive capacity: how much is too much? In: Radelet S, ed. Challenging foreign aid: a policymaker's guide to the millennium challenge account. Washington DC: Center for Global Development, 2003: 125–44.

64 Llienert I. A comparison between two public expenditure management systems in Africa. *OECD J Budgeting* 2003; **3:** 35–66.

65 UN. Statistics division. National accounts. New York: United Nations, 2009. http://unstats.un.org/unsd/nationalaccount/ (accessed Dec 14, 2009).

66 Organisation for Economic Co-Operation and Development. A system of health accounts. http://www.oecd.org/document/8/ 0,3343,en_2649_33929_2742536_1_1_1_37407,00.html#joint_oecd (accessed Dec 14, 2009).

67 IMF and IDA. Actions to strengthen the tracking of poverty-reducing public spending in Heavily Indebted Poor Countries (HIPCs). Washington DC: International Monetary Fund and World Bank, 2002. https://www.imf.org/external/np/ hipc/2002/track/032202.pdf (accessed Dec 17, 2009).

68 Huddart J, Furth R, Lyons JV. The Zambia HIV/AIDS Workforce study: preparing for scale-up. Operations research results. Bethesda, MD, USA: University Research Corporation, LLC, 2004. http://www.qaproject.org/pubs/PDFs/ORMZambiaWorkforcel.pdf (accessed Jan 19, 2010).

69 Davey G, Fekade D, Parry E. Must aid hinder attempts to reach the Millennium Development Goals? *Lancet* 2007; **367:** 629–30.

70 GFATM. Affordable Medicines Facility—malaria (AMFm). Geneva: The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2009. http://www.theglobalfund.org/en/amfm/ (accessed Dec 17, 2009).