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Does donor proliferation in development aid for health affect health service delivery and population health? Cross-country regression analysis from 1995 to 2010

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Abstract

Background: Previous literature suggests that increasing numbers of development aid donors can reduce aid effectiveness but this has not been tested in the health sector, which has experienced substantial recent growth in aid volume and number of donors.
Methods: Based on annual data for 1995–2010 on 139 low- and middle-income countries that received health sector aid from donors reporting to the OECD's Creditor Reporting System, the study used two-step system generalized method of moments regression models to test whether the number of health aid donors and an index of health aid donor fragmentation affect health services (measured by DTP3 immunization rate) or health outcomes (measured by infant mortality rate) for three subsectors of health aid.
Results: For total health aid and for the general and basic health aid subsector, controlling for economic and political conditions, increases in the number of donors were associated with increases in DTP3 immunization rate and reductions in infant mortality while increases in the donor fragmentation index were associated with decreases in DTP3 immunization rate and increases in infant mortality, though none of these relationships were statistically significant. For the population and reproductive health aid subsector, a one percent increase in the number of donors was associated with a 0.23 percent decrease in DTP3 immunization ($P < 0.01$) while a one percent increase in donor fragmentation was associated with a 0.54 percent increase in DTP3 immunization rate ($P < 0.01$); associations with infant mortality rates for this subsector were similar to those for total health aid.
Conclusion: The results do not provide clear evidence in support of the hypothesis that donor proliferation negatively impacts development results in the health sector. Aid effectiveness policy prescriptions should distinguish responses to donor proliferation versus donor fragmentation and be adapted to specific subsectors of health aid.

Keywords: Aid effectiveness, aid fragmentation, development assistance for health (DAH), global health

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Key Messages

- Previous literature suggests that increasing numbers of development aid donors can reduce aid effectiveness; however, this hypothesis has not been tested across low- and middle-income countries for health sector aid, which has increased dramatically over the past two decades.
- Contrary to prior hypotheses, the study finds no statistically significant relationship between donor proliferation in development aid for health and measures of health services and health outcomes in aid-recipient countries from 1995 to 2010.
- The results suggest that greater nuance is needed in designing policies to translate development aid into population health improvements, in particular through tailoring policies to specific country settings and health subsectors and distinguishing policy responses to donor proliferation versus donor fragmentation.

Introduction

Previous literature and international policy declarations have suggested that donor proliferation – i.e., having many donors providing development aid to the same low- or middle-income recipient country – may limit aid's effectiveness and efficiency and impede non-aid-funded development efforts (Acharya *et al.* 2006, Knack and Rahman, 2007, Organisation for Economic Co-operation and Development, 2008a, 2008b, Djankov *et al.* 2009). Such donor proliferation, and the associated phenomenon of donor fragmentation in which each donor contributes a smaller share of aid, has been linked to increased transaction costs for recipient country governments, reduced accountability for development outcomes, poaching of government staff by aid-funded projects, increased corruption, and lower economic growth (Acharya *et al.* 2006, Knack and Rahman, 2007, Organisation for Economic Co-operation and Development, 2008a, 2008b, Djankov *et al.* 2009).

These potential negative outcomes from donor proliferation are of special concern in the health sectors of low- and middle-income countries (LMICs) given the substantial growth in the number of donor organizations providing development aid for health over the past two decades (Ravishankar *et al.* 2009, McCoy *et al.* 2009, Lane and Glassman, 2007, Organisation for Economic Co-operation and Development, 2011). Donor proliferation in health sector aid reflects a confluence of trends, including global advocacy around HIV/AIDS (Shiffman, 2007, 2009), evidence about the economic development benefits of health sector investment (Sachs, 2001, 2005), publicized success stories from aid-funded health initiatives and advocacy for health aid scale-up to achieve the Millennium Development Goals (Levine *et al.* 2004, Sachs, 2005), donor fatigue with other development sectors such as agriculture (Easterly, 2009), security concerns about potential cross-border epidemic diseases (Kickbusch, 2000, Shiffman, 2006), a search for new aid delivery models that would leverage the private sector (e.g., the Global Fund to Fight AIDS, Tuberculosis, and Malaria, and GAVI the Vaccine Alliance) (Lane and Glassman, 2007), and the role of catalytic new actors such as the Bill & Melinda Gates Foundation (McCoy *et al.* 2009). With a few exceptions (Williamson, 2008), previous literature has found that increases in health sector aid volume are associated with improved health service delivery and population health outcomes, including increased coverage for diphtheria, tetanus, and pertussis (DTP) (Dietrich, 2011), increased distribution and use of insecticide treated nets (Flaxman *et al.* 2010, Akachi and Atun, 2011), reduced infant mortality (Mishra and Newhouse, 2009), and fewer AIDS-related deaths (Nunnenkamp and Öhler, 2011). However, we still lack evidence on whether the number of donors and distribution of aid across donors affects health in LMICs after accounting for aid volume.

Accordingly, this paper tests if donor proliferation and fragmentation in health sector aid affect health service delivery and population health outcomes using data on 139 countries from the recent period of health donor scale-up from 1995 to 2010. The paper examines the applicability to the health sector of existing hypotheses about donor proliferation's negative effects on development generally; if these hypotheses are true, we would expect to find that increases in donor proliferation and fragmentation in health sector aid negatively affect health service delivery and population health outcomes. The results of this analysis can help assess current policy proposals to respond to donor proliferation through harmonization of aid-funded activities among donors and alignment of donor activities with recipient country government priorities and systems, and can also inform future proposals for maximizing the health benefits of health sector development aid.

Methods

Country sample

We constructed the sample starting from the 155 countries over the 1995–2010 period that met the following criteria in at least two years: (i) eligible to receive official development assistance (ODA) (Organisation for Economic Co-Operation and Development, 2012a), (ii) received health sector aid (Organisation for Economic Co-operation and Development, 2011), and (iii) been a self-governed state (i.e., not a territory or protectorate) (UN Special Committee on Decolonization, 2015a, 2015b). To ensure consistent samples across regression model specifications, the included countries were reduced to 139 due to data limitations for some variables. The 16 countries dropped from the sample (Aruba, Bahrain, Cook Islands, French Polynesia, North Korea, South Korea, Kosovo, Malta, Mayotte, Myanmar, Nauru, Niue, Slovenia, Somalia, Syria, and Wallis & Futuna) together represent <1.1% of total health aid commitments during our analysis period.

Variables and data sources

Data on aid volumes come from the OECD's Creditor Reporting System (CRS), to which 59 donors report annually (Organisation for Economic Co-operation and Development, 2011). These donors include 23 OECD Development Assistance Committee (DAC) member countries (e.g., United States), four non-DAC countries (e.g., United Arab Emirates), 31 multilateral/international organization donors (e.g., World Bank International Development Association), and one private foundation (Bill & Melinda Gates Foundation),

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Box 1 Net versus gross donor proliferation measures

As an example, if a donor reports providing both sector 120 and sector 130 aid to a particular recipient country in a given year, this donor organization would count as 1 donor for the net number of donors measure (i.e., 1 donor regardless of how many health aid sectors supported) but the same donor organization would count as 2 donors for the gross number of donors measure (i.e., as 1 donor for sector 120 and 1 donor for sector 130). From the perspective of the recipient country, receiving two different types of health aid (e.g., sector code 120 and 130) may or may not increase transaction costs. If both types are channeled into the same program and the recipient engages with a single point of contact/unit within the donor agency (e.g., health attaché at the embassy), then the net number of donors count would be more appropriate. If the two sector codes reflect two different projects or two different points of contact/units within the donor agency (e.g., development agency and medical research agency within the donor government) then the gross number of donors would be more appropriate.

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although all donors did not report in all years of this analysis (Supplementary Material, Table S1). As this source does not include reporting from emerging donors (e.g., Brazil, Russia, India, China) or private sector donors, it is an underestimate of true aid volumes and number of donors. Due to differences in CRS coverage levels prior to 1995, we use data on official development assistance (ODA) from 1995 to 2010 (Organisation for Economic Co-operation and Development, 2011, Organisation for Economic Co-Operation and Development, 2012b), the years prior to, during, and following intensive donor proliferation in global health. OECD CRS disbursement data are inconsistently reported by donors prior to 2002 (Organisation for Economic Co-operation and Development, 2011). Previous research (Mishra and Newhouse, 2009) estimated the correlation at 0.66 between the available health aid commitment and disbursement data for 1990–2004. Comparing with imputed health aid disbursement data for 1995–2008 from the Institute for Health Metrics and Evaluation (Institute for Health Metrics and Evaluation, 2010), the correlation with health aid commitments in our data set was 0.8041 for concurrent years, 0.8037 for one-year lagged commitments, and 0.78 for two-year lagged commitments (as commitments may take time to translate into disbursements). Following previous development aid literature, we use commitments to obtain a longer time series. Using commitments rather than disbursements is also appropriate given the hypothesis that donor proliferation affects health through increased transaction costs, i.e., search, bargaining, and contracting costs that occur during donor-recipient negotiations (Lawson, 2009). Even if committed aid is never disbursed, donor proliferation at the level of aid commitments could divert the limited human resource capacity of recipient country governments away from health program implementation.

We define total health aid as the sum of CRS sector code 120 for General and Basic Health, sector code 130 for Population and Reproductive Health Policy and Programmes, and sector code 140 for Water and Sanitation (Supplementary Material, Table S2). As water and sanitation aid is sometimes excluded from studies of health aid because it is not channeled through the recipient country's Ministry of Health or health care delivery system, we also model sector code 120 and 130 aid separately.

We measure donor proliferation as a count of the net number of donors that committed health aid under CRS sector codes 120, 130, or 140, which counts a donor only once even if it commits aid to more than one sector code. Avoiding double counting in this way is appropriate if recipients interact with each donor about all the types of aid that the donor supplies at the same time (for example, discussing both a reproductive health project (sector 130) and a hospital construction project (sector 120) in the same meeting). Using the net number of donors may underestimate the true transaction costs for recipients if different parts of a donor or recipient organization handle different types of aid, necessitating separate transactions for each type of aid provided. In the robustness checks, we run the analysis using the gross number of donors in which each donor is counted once for each sector code it supports; a single donor may therefore be counted up to three times in the gross number of donors but only once in the net number of donors (**Box 1**). We measure donor fragmentation as one minus a Herfindahl Index of donor aid shares:

$DonorFragmentation = (1 - HI)$ where $HI = \sum_{i=1}^{n} share_i{}^2$ for donor i in a recipient country with n donors in its health sector. Values of donor fragmentation closer to 1 indicate a more fragmented donor environment with a more equal distribution of shares among donors (i.e., many donors with small shares of aid). Both the number of donors and donor fragmentation index were constructed based on donor-recipient country pairs from the CRS. For each recipient country, aid was attributed to the donor reporting the aid commitments in the CRS regardless of the original source of funds (e.g., transfers from the US government to the regular budget of a UN agency were attributed to the UN agency if that agency was recorded as the donor committing aid to the recipient country in the CRS). We excluded aid reported to the CRS for which no individual recipient country was listed (e.g., regional-level aid, unspecified recipients).

Data on the dependent variables are from the World Bank's World Development Indicators and the World Health Organization's Global Health Observatory (World Health Organization, 2011, 2012, World Bank, 2012). We selected indicators that were available across the countries and years in our sample, were plausible results of health aid-funded activities, and had been used in previous literature to enhance comparability of the results. Our selected measure of health service delivery was DTP3 immunization rate and our population health outcome was infant mortality rate.

Data on the covariates in our models are drawn from sources commonly used in the development aid literature: the limits on political and civil liberties measure is taken from Freedom House (Freedom House, 2012) and presence of civil conflict is taken from the UCDP/PRIO Armed Conflict Dataset (Uppsala Conflict Data Program, 2012). The covariates were selected based on the hypothesized mechanisms by which donor proliferation affects development, specifications used in previous literature, and known drivers of donor proliferation. All variables were natural log transformed with the exception of the conflict in year binary indicator variable. Table 1 provides descriptive statistics; Supplementary Material, Table S3 provides descriptions and sources for each variable.

Table 1. Descriptive statistics for pooled sample of 139 countries, 1995–2010

Variable	Mean	Standard Deviation	Min[a]	Median	Max	Number of country-year observations
Infant mortality rate	47.52	32.39	4.5	37.1	159.4	2085
DTP3 immunization rate	80.56	18.47	16	86	99	2044
Total health aid volume (2009 USD millions)	$1000	$191.69	$0.00005	$32.46	$2865.24	2111
Total health aid net number of donors	9.94	6.95	0	9	29	2224
Total health aid donor fragmentation	0.55	0.26	−0.005	0.63	0.90	2110
General & basic health aid volume (2009 USD millions)	$36.30	$73.59	$0.00002	$11.07	$944.05	2047
General & basic health aid net number of donors	6.95	5.37	0	6	25	2224
General & basic health aid donor fragmentation	0.47	0.27	0	0.54	1	2048
Population & reproductive health aid volume (2009 USD millions)	$30.18	$77.52	−$16.08	$6.06	$1083.89	1782
Population & reproductive health aid net number of donors	4.75	4.60	0	4	24	2224
Population & reproductive health aid donor fragmentation	0.39	0.27	−2.12	0.43	1	1788
GDP per capita (2010 USD)	$3632.33	$3820.93	$115.44	$2423.52	$20257.96	2193
Limits on political and civil liberties (2=Free, 14=Not Free)	7.76	3.56	2	8	14	2188
Conflict in year	0.17	0.37	0	0	1	2224

[a]*Negative values for minimum total health aid donor fragmentation, population and reproductive health aid volume, and population and reproductive health aid donor fragmentation reflect 3 country-year observations in which the amount of aid outflows (e.g., repayments for loans) from the recipient country to a donor exceeded the inflows of aid from that donor to the recipient country, resulting in net negative aid volume and a negative donor share in the donor fragmentation index. When this donor's negative share was larger than the sum of the positive health aid shares of other donors, the overall donor fragmentation index was negative.*

Table 2. Pearson correlation coefficients among variables for pooled sample of 139 countries, 1995–2010, total health aid (obs: 1918)

	Infant mortality rate	DTP3 immunization rate	Health aid volume	Health aid net number of donors	Health aid donor fragmentation	GDP per capita	Political and civil liberties limitations	Conflict in year
Variables in original units								
Infant mortality rate	1.0000							
DTP3 immunization rate	−0.6797	1.0000						
Health aid volume	0.1377	−0.0978	1.0000					
Health net number of donors	0.2628	−0.0908	0.5646	1.0000				
Health donor fragmentation	0.3088	−0.1750	0.2103	0.6705	1.0000			
GDP per capita	−0.5561	0.3001	−0.2095	−0.3771	−0.3632	1.0000		
Limits on political and civil liberties	0.3826	−0.2518	0.0824	0.1802	0.2248	−0.2464	1.0000	
Conflict in year	0.0862	−0.0506	0.2348	0.1954	0.1179	−0.1141	0.1174	1.0000
Log-transformed variables used in regression models[1]								
Infant mortality rate	1.0000							
DTP3 immunization rate	−0.5743	1.0000						
Health aid volume	0.3723	−0.1590	1.0000					
Health net number of donors	0.2914	−0.0943	0.8026	1.0000				
Health donor fragmentation	0.3050	−0.1494	0.4741	0.7585	1.0000			
GDP per capita	−0.7555	0.3839	−0.4404	−0.3992	−0.3816	1.0000		
Limits on political and civil liberties	0.3957	−0.2684	0.2931	0.3118	0.3051	−0.3637	1.0000	
Conflict in year	0.1175	−0.0294	0.2368	0.1870	0.1154	−0.1152	0.1450	1.0000
Within-country variation only[2]								
Infant mortality rate	1.0000							
DTP3 immunization rate	0.1469	1.0000						
Health aid volume	0.0802	0.0701	1.0000					
Health net number of donors	−0.0311	0.0345	0.3570	1.0000				
Health donor fragmentation	−0.0017	−0.0300	−0.2170	0.3636	1.0000			
GDP per capita	−0.1538	−0.1386	0.0449	0.0686	0.0226	1.0000		
Limits on political and civil liberties	0.0977	0.0039	−0.0341	0.0039	0.0202	−0.0645	1.0000	
Conflict in year	0.0724	−0.0116	0.0470	−0.0196	−0.0262	−0.0281	0.1207	1.0000

(1) Conflict in year was not log transformed.

(2) Correlations between residuals from fixed effect regressions of each variable on country- and year-fixed effects only to isolate changes in each variable over time within each country.

Health aid volume, number of donors, and donor fragmentation were all positively correlated in both levels and when log-transformed (Table 2; Supplementary Materials, Tables S4 and S5). For total health aid in original units, the Pearson correlation coefficients in the pooled sample of all countries and years were 0. 57 between aid volume and the net number of donors, 0.21 between aid volume and donor fragmentation, and 0.67 between the net number of donors and donor fragmentation. When log-transformed

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for analysis, the Pearson correlation coefficients increased to 0.80 between aid volume and the net number of donors, 0.47 between aid volume and donor fragmentation, and 0.76 between the net number of donors and donor fragmentation. When only within-country variation was considered, these correlations were 0.36 between aid volume and net number of donors, −0.22 between aid volume and donor fragmentation, and 0.36 between net number of donors and donor fragmentation.

Model specification

Our primary specification is a linear regression model with a lagged dependent variable and fixed effects for each country and time period estimated using two-step system generalized method of moments (GMM). This approach removes variation due to unobserved features of recipient countries that do not change over time (e.g., a country's geographic location or colonial heritage) as well as time-specific events affecting all countries (e.g., a global financial crisis or new medical discovery), which could confound estimation of donor proliferation's effect on health. For analysis, we average each variable over three-year periods to smooth possible measurement error, giving us a panel data set of 139 countries measured over five three-year time periods.

The equation we want to estimate is:

$$H_{i,t} = \delta(H_{i,t-1}) + (D'_{i,t-k})\beta + (X'_{i,t-k})\theta + \alpha_i + \tau_t + \varepsilon_{i,t} \quad (1)$$

where $H_{i,t}$ is a measure of health program outputs or population health outcomes in recipient country i in time period t, β is a vector of effects of donor proliferation on health, $D_{i,t-k}$ is a vector of measures of donor proliferation in recipient country i in time period t, θ is a vector of coefficients on the time-varying covariates contained in the matrix $X_{i,t-k}$, α_i is a country fixed effect capturing time-invariant characteristics of the recipient, τ_t is a time period fixed effect capturing time-specific events common across countries, and $\varepsilon_{i,t}$ is a random error term. Donor proliferation and covariates are lagged by *k* time periods to address concerns about reverse causality and because it takes time for donor aid activities to be translated into health outcomes. The time-varying covariates, such as national income, limits on political freedom, or health sector aid volume, are lagged by the same period as donor proliferation to reduce the potential for feedback from donor proliferation to the covariates and because their potential effects on health are also likely to manifest themselves only after a delay. We lag all right-hand-side variables by one time period in the main analysis.

For two-step system GMM, we begin by taking first differences, subtracting the previous time period's value from the current period's value for each variable:

$$(H_{i,t} - H_{i,t-1}) = \delta(H_{i,t-1} - H_{i,t-2}) + (D_{i,t-k} - D_{i,\ t-k-1})'\beta + (X_{i,t-k} - X_{i,\ t-k-1})'\theta + (\alpha_i - \alpha_i) + (\tau_t - \tau_{t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,\ t-1}) \quad (2)$$

This model, which includes a one-period-lagged value of the health dependent variable, can be rewritten using Δ to indicate the first difference as follows:

$$\Delta H_{i,t} = \delta(\Delta H_{i,t-1}) + (\Delta D'_{i,t-k})\beta + (\Delta X'_{i,t-k})\theta + \Delta\tau_t + \Delta\varepsilon_{i,t} \quad (3)$$

Taking first differences removes the fixed effect but mechanically creates a correlation between the first differences in lagged health and in the error term as $\varepsilon_{i,t-1}$ is part of both $\Delta\varepsilon_{i,t}$ and $H_{i,t-1}$, and therefore also part of $\Delta H_{i,t-1}$. We therefore use instrumental variables constructed from longer lags of the dependent variable, donor proliferation, and the covariates, which is valid if we assume that these lagged levels are uncorrelated with the first difference in the error term (Roodman 2009a). This assumption may be unlikely to hold if the variables being instrumented are persistent over time such that past levels are not strong predictors of future changes, leading to weak instruments and biased coefficient estimates (Roodman 2009a, 2009b), which may be the case for some health outcomes such as infant mortality rate (Mishra and Newhouse 2009). We therefore add another set of instrumental variables, using lagged first differences as instruments for the current levels of the variables in equation (3).

The result is a system of two equations with two different sets of instrumental variables: equation (3) in levels that are instrumented with lagged first differences, and equation (3) in first differences that are instrumented with lagged levels. As potentially all lags of two years and longer are available as instruments, there may be more instruments than there are variables in the original equations (Roodman, 2009b); we therefore collapse the instrument set and as a robustness check we further limit the number of instruments to two-period lags. We use the xtabond2 procedure in Stata version 11 to implement two step system GMM estimation with robust standard errors clustered on the recipient country and the Windmeijer correction for finite samples (Roodman, 2009a). We estimate models for total health aid (sum of aid for sector codes 120, 130, and 140), general and basic health aid (sector code 120 aid only), and population and reproductive health aid (sector code 130 aid only).

Results

Time trends

In the analysis sample of 139 countries, the median level of annual total health sector aid increased roughly threefold between 1995 and 2010, with general health aid and population and reproductive health aid showing fairly steady upward trends while water and sanitation aid was more volatile year-to-year (Figure 1A and B). Compared to 1995, by 2010 the median number of donors per country had increased by 7 for general and basic health aid, by 7 for population and reproductive health, and by 5 for water and sanitation aid (Figure 1C). The number of donors providing aid to more than one health subsector increased over time, as shown by the divergence between the net and gross numbers of health aid donors (Figure 1D). The median level of donor fragmentation increased between 1995 and 2001 for all sectors of health aid and then leveled off thereafter (Figure 2A), reflecting that around 2001–2002, the average volume of health sector aid started increasing at a faster rate than the average number of donors. Median donor fragmentation increased especially sharply between 1999 and 2002 for population and reproductive health aid, which includes aid to combat HIV/AIDS. Median annual total health aid (the sum of sectors 120, 130, and 140) remained in a constant range between 12 and 18% of all aid for this sample of recipients throughout the 1995 to 2010 period (Figure 2B), while the median percent of all donors who provided health aid increased from 32 to 52%.

System GMM model results

For total health aid, increases in the number of health aid donors in the previous period were associated with reductions in the infant mortality rate in the current period while increases in the health aid donor fragmentation index in the previous period were associated

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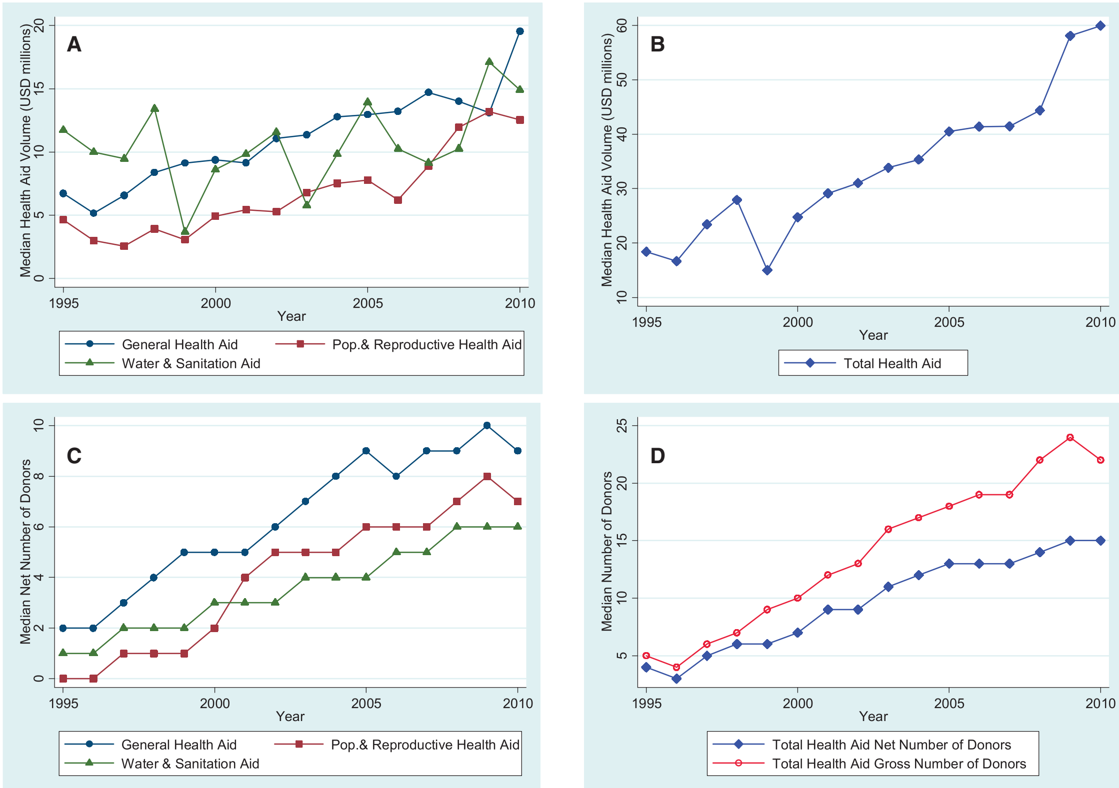

Figure 1. Median health aid volume and median number of donors by year and type of health aid, 1995–2010. Panel **(A)** shows the median volume of aid in millions of 2009 U.S. dollars per recipient country in each year for each of three subsectors of health aid: general and basic (120), population and reproductive (130), and water and sanitation (140). Panel **(B)** shows the median volume of aid in millions of 2009 U.S. dollars per recipient country for total health aid (the sum of the three subsectors of health aid in Panel (A)). Panel **(C)** shows the median number of donors providing aid for each of the three subsectors of health aid in Panel (A). Panel **(D)** shows the median gross and net number of donors providing total health sector aid; the gross number of donors counts a donor once for each subsector of health aid and the net number of donors counts a donor only once even if the donor provides aid for multiple subsectors of health aid. In all panels, the median is taken by year across all recipient countries in the sample ($n = 139$).

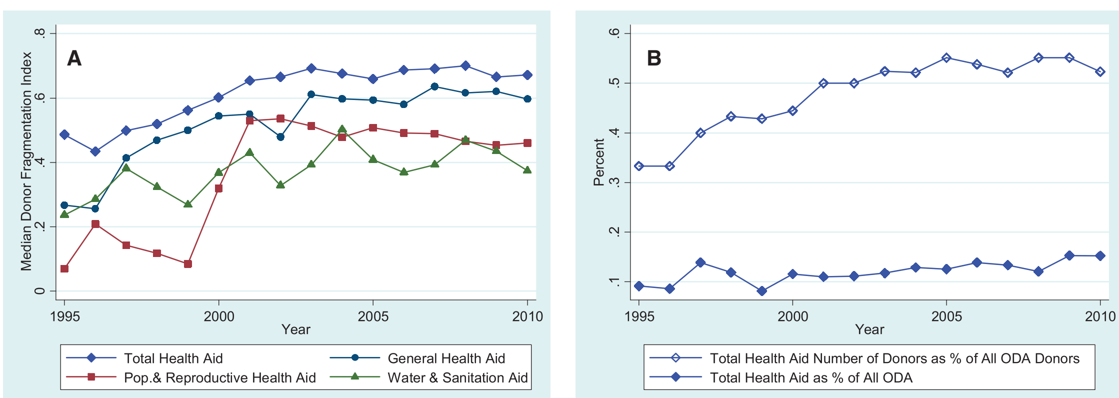

Figure 2. Median health sector aid donor fragmentation, median number of health sector aid donors as percent of all donors, and median health sector aid as percent of all aid, 1995–2010. Panel (**A**) shows the median donor fragmentation index value for a recipient country for each of three subsectors of health aid (general and basic (120), population and reproductive (130), and water and sanitation (140)) and total health aid (the sum of the three subsectors). The donor fragmentation index is calculated as one minus a Herfindahl index of donor aid shares. Panel (**B**) shows the median net number of total health aid donors as a percent of all donors (health and non-health) and the median total health aid volume as a percent of all aid (health and non-health) to a recipient country. In all panels, the median is taken by year across all recipient countries in the sample ($n = 139$).

with increases in the infant mortality rate in the current period, but neither effect was statistically significant across the models examined (Table 3, models 1–4). By comparison, the effects on DTP3 immunization rate were not stable in direction across models. When controlling only for the lagged dependent variable and health aid volume, increases in the number of total health aid donors in the previous period were associated with lower DTP3 rates in the current period (Table 3, model 5) while increases in donor

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Table 3. Effects of donor proliferation and fragmentation on infant mortality rate and DTP3 immunization rate: Total Health Aid.

	Dependent Variable: Infant Mortality Rate				Dependent Variable: DTP3 Immunization Rate			
Model	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Lagged dependent variable	1.095***	1.099***	1.114***	1.108***	0.928***	0.969***	0.908***	0.941***
	(0.0264)	(0.0340)	(0.0336)	(0.0336)	(0.159)	(0.135)	(0.162)	(0.123)
Health aid volume	−0.00771	−0.00396	−0.00630	−0.00484	0.0997*	0.0728**	0.0671	0.0324
	(0.0438)	(0.0345)	(0.0321)	(0.0256)	(0.0437)	(0.0274)	(0.0425)	(0.0279)
Health aid net number of donors	−0.0157		−0.0615	−0.0781	−0.0294		−0.00410	0.00759
	(0.0337)		(0.0878)	(0.0512)	(0.0723)		(0.158)	(0.127)
Health aid donor fragmentation		0.00266	0.218	0.184		0.125	−0.0830	−0.175
		(0.114)	(0.328)	(0.176)		(0.301)	(0.475)	(0.308)
GDP per capita				−0.0234				−0.0414
				(0.0248)				(0.0305)
Limits on political & civil liberties				−0.0600				−0.0109
				(0.0419)				(0.0459)
Conflict in year				−0.0118				0.0548
				(0.0423)				(0.0689)
Obs	537	537	537	525	530	530	530	522
# Countries	139	139	139	138	138	138	138	138
# of Instruments	13	13	16	25	13	13	16	25
Hansen test p-value	0.133	0.0857	0.765	0.563	0.582	0.373	0.536	0.855
AR(2) test p-value	0.732	0.773	0.428	0.502	0.659	0.902	0.705	0.593
Instrument limitations	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed

All variables except conflict in year are natural log transformed. All predictors and covariates are lagged by one period. Standard errors in parentheses.
$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

fragmentation in the previous period were associated with higher DTP3 rates in the current period (Table 3, model 6), though neither effect was statistically significant. Total health aid volume had a statistically significant effect in both models, with a one percent increase in aid in the previous period increasing DTP3 immunization rates in the current period by 0.07–0.1% (Table 3, models 5 and 6). When both donor proliferation and donor fragmentation are included in the model, health aid volume loses its statistical significance and the effect of donor fragmentation becomes negative (Table 3, model 7). When controlling for economic and political conditions, the number of donors in the previous period becomes positively associated with current period DTP3 rates, though still not statistically significant (Table 3, model 8). The lagged dependent variable was highly statistically significant and close to one in all specifications, reflecting the persistence of the dependent variables over time.

For general health aid only, increases in the number of health aid donors in the previous period were associated with reductions in the infant mortality rate and increases in the DTP3 immunization rate in the current period across all models, though none of these effects was statistically significant (Table 4, models 1–8). The results for health aid donor fragmentation were inconsistent in direction across models, though none was statistically significant. Increases in the health aid donor fragmentation index in the previous period were associated with reductions in the infant mortality rate when controlling for the lagged dependent variable, health aid volume, and donor proliferation (Table 4, models 2 and 3) but associated with increases in the infant mortality rate when adding controls for economic and political conditions (Table 4, model 4). For DTP3 immunization rate, increases in health aid donor fragmentation were associated with increased DTP3 rates when controlling only for the lagged dependent variable and health aid volume, but associated with lower DTP3 rates when adding donor proliferation and economic and political control variables to the model (Table 4, models 6–8). The effect of health aid volume was only statistically significant in the models with donor fragmentation and without number of donors (Table 4, models 2 and 6), with a one percent increase in general health aid associated with a 0.03% reduction in infant mortality rate and a 0.04% increase in DTP3 immunization rate. The lagged dependent variable was highly statistically significant and close to one in all specifications.

For population and reproductive health aid only, the results were similar to those for total health aid for infant mortality rate but not for DTP3 immunization rate. For infant mortality rate, increases in the number of health aid donors in the previous period were associated with reductions in the infant mortality rate in the current period while increases in the previous period's donor fragmentation were associated with higher current period infant mortality rates, though none of these effects was statistically significant (Table 5, models 1–4). Lagged health aid volume had a statistically significant negative effect on infant mortality in the model with only the lagged dependent variable and donor fragmentation (Table 5, model 2), with a one percent increase in aid associated with a 0.03% reduction in infant mortality. For DTP3 rates, increases in the previous period's number of donors were associated with lower DTP3 rates in the current period (Table 5, models 5–8) while increases in the previous period's donor fragmentation was associated with lower DTP3 rates when controlling only for the lagged dependent variable and health aid volume (Table 5, model 6) but higher DTP3 rates when number of donors and economic and political covariates were added to the model (Table 5, models 7 and 8). The effects of the previous period's number of donors and donor fragmentation were both statistically significant at the 0.01 level in the final model controlling for economic and political conditions (Table 5, model 8). This final model

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Table 4. Effects of donor proliferation and fragmentation on infant mortality rate and DTP3 immunization rate: General Health Aid

	Dependent Variable: Infant Mortality Rate				Dependent Variable: DTP3 Immunization Rate			
Model	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Lagged dependent variable	1.122***	1.129***	1.115***	1.142***	1.080***	1.063***	1.101***	0.979***
	(0.0298)	(0.0355)	(0.0237)	(0.0375)	(0.178)	(0.116)	(0.166)	(0.141)
Health aid volume	−0.0248	−0.0321*	−0.0226	−0.00787	0.0309	0.0391*	0.0162	−0.00233
	(0.0143)	(0.0149)	(0.0132)	(0.0126)	(0.0316)	(0.0190)	(0.0326)	(0.0263)
Health aid net number of donors	−0.0180		−0.0155	−0.0431	0.0422		0.110	0.00769
	(0.0243)		(0.0488)	(0.0260)	(0.0920)		(0.155)	(0.0871)
Health aid donor fragmentation		−0.0759	−0.0162	0.0913		0.173	−0.181	−0.0588
		(0.135)	(0.197)	(0.101)		(0.209)	(0.401)	(0.263)
GDP per capita				0.0145				−0.0438
				(0.0266)				(0.0275)
Limits on political & civil liberties				−0.0493				−0.0219
				(0.0403)				(0.0486)
Conflict in year				−0.00951				0.0668
				(0.0268)				(0.0834)
Obs	533	533	533	521	526	526	526	518
# Countries	139	139	139	138	138	138	138	138
# of Instruments	13	13	16	25	13	13	16	25
Hansen test p-value	0.368	0.314	0.583	0.177	0.364	0.318	0.561	0.694
AR(2) test p-value	0.687	0.765	0.710	0.569	0.786	0.726	0.807	0.941
Instrument limitations	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed

All variables except conflict in year are natural log transformed. All predictors and covariates are lagged by one period. Standard errors in parentheses.
$^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$.

Table 5. Effects of donor proliferation and fragmentation on infant mortality rate and DTP3 immunization rate: Population & Reproductive Health Aid.

	Dependent Variable: Infant Mortality Rate				Dependent Variable: DTP3 Immunization Rate			
Model	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Lagged dependent variable	1.100***	1.107***	1.092***	1.144***	0.519**	0.759***	0.650***	0.811***
	(0.0213)	(0.0267)	(0.0235)	(0.0615)	(0.190)	(0.189)	(0.155)	(0.109)
Health aid volume	−0.0197	−0.0371*	−0.00310	−0.00846	0.0427	0.0128	0.0637	0.0512
	(0.0181)	(0.0156)	(0.0190)	(0.0146)	(0.0282)	(0.0160)	(0.0339)	(0.0295)
Health net number of donors	−0.0347		−0.0924	−0.0865	−0.115		−0.168	−0.231**
	(0.0357)		(0.0944)	(0.0548)	(0.0665)		(0.100)	(0.0857)
Health donor fragmentation		0.0287	0.176	0.193		−0.147	0.172	0.544**
		(0.0736)	(0.212)	(0.128)		(0.211)	(0.183)	(0.208)
GDP per capita				0.0457				−0.0588**
				(0.0581)				(0.0191)
Limits on political & civil liberties				−0.0417				−0.0876*
				(0.0348)				(0.0358)
Conflict in year				0.0390				0.0936
				(0.0438)				(0.0683)
Obs	475	475	475	467	469	469	469	465
# Countries	137	137	137	136	136	136	136	136
# of Instruments	13	13	16	25	13	13	16	25
Hansen test p-value	0.0450	0.137	0.107	0.678	0.0604	0.0219	0.108	0.661
AR(2) test p-value	0.610	0.605	0.434	0.457	0.481	0.724	0.655	0.653
Instrument limitations	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed	Collapsed

All variables except conflict in year are natural log transformed. All predictors and covariates are lagged by one period. Standard errors in parentheses.
$^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$.

results indicate that a one percent increase in the number of donors providing population and reproductive health aid in the previous period is associated with a 0.23% reduction in DTP3 immunization rates in the current period, while a one percent increase in the population and reproductive health aid donor fragmentation index in the previous period is associated with a 0.54% increase in DTP3 immunization rates in the current period.

When models were run limiting instruments to two period lags as a robustness check, neither number of donors nor donor fragmentation was statistically significant in any specification

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(Supplementary Materials, Tables S6–S8). The only statistically significant effects were those of the lagged dependent variables (Supplementary Materials, Tables S6–S8, all models), population and reproductive health aid volume when controlling only for the lagged dependent variable and donor fragmentation (Supplementary Material, Table S8, model 2) and for certain economic and political covariates (Supplementary Material, Table S8, models 4 and 8). Model results were qualitatively similar when the gross number of donors was used instead of the net number of donors (results available upon request).

Discussion

Previous literature and aid effectiveness policy declarations have suggested that donor proliferation and fragmentation can reduce development gains. If true in all sectors, we would expect to see that increases in the number of health sector donors and the degree of health sector donor fragmentation reduce health service delivery and worsen health outcomes. Instead, the direction of the estimated effects suggests that donor proliferation and fragmentation do not appear to have the consistent negative effects on health hypothesized by previous literature. Number of donors and donor fragmentation only had statistically significant effects on DTP3 immunization rates in one of the models examined for population and reproductive health aid (sector 130) and no statistically significant effects in the models for total health aid or general health aid. That the only statistically significant effect was found in a model of our health service delivery measure rather than our health outcome measure may reflect that health services are more proximate to the typical domains of intervention of aid-funded health projects, whereas more distal health outcomes are influenced by broader environmental factors beyond health services. This may also reflect certain data and modelling limitations, discussed below, or that donor proliferation or fragmentation actually has limited impact on health program implementation and health outcomes as measured in this study.

The results suggest that the effects of donor proliferation and donor fragmentation may vary within the health sector such that looking at total health aid in aggregate may conceal impacts of donor proliferation and fragmentation operating at a subsector level. For example, when controlling for economic and political conditions, the number of donors has a positive but non-significant effect on DTP3 immunization rate for total health aid and general health aid but a negative and statistically significant effect on DTP3 rates for population and reproductive health aid. The results also suggest that donor proliferation (i.e., the number of donors) and donor fragmentation (i.e., a more equal distribution of aid among donors) are capturing different patterns of variation between health aid donors and health. For example, in our preferred specification controlling for economic and political conditions, though not statistically significant, donor proliferation is associated with lower infant mortality rates whereas donor fragmentation is associated with higher infant mortality rates across all types of health aid examined. This pattern – of more health sector donors being beneficial but more fragmented aid being deleterious – is also seen in the DTP3 models for total health aid and general health aid, though not for population and reproductive health aid; this latter divergent pattern may reflect the substantial increase in aid for HIV/AIDS under population and reproductive health aid during the analysis period, with donor fragmentation increasing faster than either donor proliferation or aid volume as shown in Figures 1 and 2. As donor proliferation tends to increase donor fragmentation, the net effect of an additional health sector donor will include its effects on both donor proliferation and fragmentation (e.g., for population and reproductive health aid, lower DTP3 immunization rates due to donor proliferation but higher DTP3 immunization rates due to the increased donor fragmentation from that donor's entry, assuming all other donors and their aid volumes remain constant). Given these offsetting effects between donor proliferation and donor fragmentation, the model results imply that the net effect on health of a new donor entering the health sector will depend on the initial degree of donor fragmentation and the amount of new aid that the new donor brings. These differences demonstrate the importance of clearly conceptualizing the distinction between donor proliferation and fragmentation and their interplay, and formulating policy recommendations accordingly.

Limitations

Identifying the effect of donor proliferation in health sector aid on health is a challenging empirical problem with features common to cross-country regression analyses of development aid using observational panel data (Easterly, 2009), such as endogeneity, unobserved heterogeneity, measurement error, as well as missing data, which may be particularly acute for low- and middle-income aid-recipient countries with weak statistical capacity. Our analysis should therefore be interpreted in light of several limitations. Data limitations precluded inclusion of some variables that theory predicts should enter the models, such as the recipient country government's capacity, corruption, and the extent of harmonization, alignment, and ownership within the health sector, and some health measures that might be more closely linked to health aid subsectors (e.g., percent of the population with access to clean water). We used aid commitments rather than disbursements, which may underestimate the effect of donor proliferation through mechanisms such as the hiring away of government staff to work on aid-funded projects. Data limitations also reduced the sample size in our models. If the countries that were excluded differed systematically from those that were included in the sample, then the resulting estimates may not capture the true average effect of donor proliferation on health across all health aid recipient countries. Our models used a set of covariates informed by previous literature about the causes of donor proliferation; however, there is no consensus in the literature on which combination of covariates should be included when modelling the effects of development aid (Easterly, 2009). If we have omitted important time-varying covariates, our model estimates may be inconsistent. Although there is some discussion in previous literature about offsetting effects of political and economic conditions on health over the short term (cf. Deaton 2006, Ruhm 2004), the fact that these covariates were not consistently statistically significant across models suggests that measurement error is a serious limitation of the analysis. Measurement error is also likely in the variables for health aid volume and number of donors due to the limitations of the OECD CRS, as discussed above. The lack of statistical significance for GDP per capita in particular may result from weak instruments in system GMM given the persistence of GDP per capita as a series, or may reflect the short-term nature of this analysis over a 15-year period. The sample size and measurement error limitations also increase the risk of multicollinearity among some of the predictor variables, which would reduce the stability of our coefficient estimates. In light of these challenges, our approach in this paper has been to use the most robust regression estimation methods for this type of dynamic panel data analysis, which are standard in the development aid

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literature, and to transparently report the sensitivity of results to modelling choices such as approaches to limit instrument proliferation.

Conclusions

This study advances the literature in several ways. The paper presents what is, to our knowledge, the first empirical test of whether donor proliferation and donor fragmentation in health sector aid *per se* affect health service delivery and population health outcomes. The effect of donor fragmentation on economic growth, corruption, bureaucratic quality, and aid volatility has been examined previously (Knack and Rahman, 2007, Fielding and Mavrotas, 2008, Djankov *et al*. 2009), but this is the first study to examine its effect on health. This is also the first study to test the effect of donor proliferation, measured as a count of the number of unique donors providing health sector aid to a recipient country, on health. The study investigates subsectors of health aid as well as total health aid, and estimates models for multiple health measures, including both health service delivery and health outcomes to explore whether the relationship varied by the type of health aid and health measure.

The study does not find a consistent statistically significant relationship between donor proliferation or fragmentation in health sector aid and the selected measures of health service delivery or health outcomes. While acknowledging the limitations of this first effort to empirically evaluate this question across countries over time, the absence of strong evidence for such a relationship in this study suggests that growth in the number and diversity of donors may not have the magnitude of negative consequences suggested by previous literature and aid effectiveness policy declarations. The degree of effort put into applying aid effectiveness principles of harmonization, alignment, and ownership may need to be weighed against other factors that could have more direct or larger impact on the translation of aid into better health services and outcomes. Future research and policy prescriptions to enhance the effectiveness of development aid for health should differentiate the potential challenges posed by donor proliferation from those of donor fragmentation and examine these within specific subsectors of health aid. Improving measurement of donor proliferation and fragmentation, as well as of other contextual variables that theory suggests should enter into models of donor proliferation's effects on health program performance, is another important direction for future cross-country research.

Supplementary Data

Supplementary data are available at *HEAPOL* online

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