Research Paper

Constraints on foreign aid effectiveness in the water, sanitation, and hygiene (WaSH) sector

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ABSTRACT

Numerous studies have sought to empirically test the effectiveness of foreign aid as a tool for international development, with often inconsistent or contradictory results. New sources of disaggregated aid data now allow researchers to test the impact of individual sectors of aid on sector-specific outcomes. The paper investigates the effectiveness of foreign aid in the water, sanitation, and hygiene (WaSH) sector and seeks to identify constraints on WaSH aid effectiveness in recipient countries. Multilevel latent growth, dynamic panel, and instrumental variable regression models were estimated on a panel dataset comprising 125 recipient countries over 20 years. WaSH aid was consistently associated with improved health outcomes in middle-income countries; no effect on those outcomes was observed in low-income countries. Potential constraints on the effectiveness of WaSH aid – including political, economic, institutional, and technical constraints – were examined using subgroup analysis. The effectiveness of WaSH aid was found to have been constrained by government ineffectiveness and regulatory quality in recipient countries. Countries with large rural populations also appear to have benefitted less from WaSH aid than more urbanized recipient countries.

Key words | drinking water, foreign aid effectiveness, sanitation

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INTRODUCTION

This study examines the effectiveness of foreign aid in the water, sanitation, and hygiene (WaSH) sector. A series of panel data regressions were estimated on a dataset comprising 125 low- and middle-income countries from 1995 through 2014 to test for a relationship between per capita WaSH aid received and changes in the proportion of the population in recipient countries with access to improved sources of drinking water and sanitation, as defined by the Joint Monitoring Program for Water and Sanitation (JMP), and in the disease burden, measured by the under-five mortality rate, controlling for potentially confounding factors. Results suggest that WaSH aid has had a beneficial impact on health outcomes in middle-income recipient countries, but has been less effective at improving health in low-income countries. The effectiveness of WaSH aid appears to be constrained by institutional and demographic conditions in the poorest recipient countries, including especially ineffective governance, poor regulatory quality, and large rural populations.

Foreign aid in the WaSH sector

This study contributes to a vast literature assessing the effectiveness of foreign aid as a tool for development and, more specifically, to an emerging body of research examining the impact of aid in specific sectors on sector-specific

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goals (see Hicks *et al.* 2008; Tierney *et al.* 2011). To distinguish WaSH aid from other sectors of foreign aid, this study relies on the coding system of the AidData dataset, which assigns sector codes to individual aid-funded projects based on the description of the project in the donor's records. For the purposes of this study, WaSH aid is defined based on AidData's Water Supply and Sanitation Purpose Code Group; these projects include the construction of wells and other drinking water infrastructure, desalination projects, water conservation initiatives, water management capacity building, water pollution control, sewage construction, dam and reservoir construction, municipal waste management, and water assessment studies, among others. Excluded are those projects that are primarily for irrigation or large hydroelectric dams, although such projects may have WaSH sector components (see Tierney *et al.* 2011).

Over the past half century, aid in the WaSH sector grew from approximately $800 million in 1960 to a high of nearly $14 billion in 2009, measured in constant (2017) US dollars. The World Bank Group is by far the largest source of WaSH aid, accounting for nearly 30% of total commitments for WaSH projects. Among bilateral donors, Japan heads the pack, followed by Germany and the United States. Altogether, 68 donors have been involved in the sector, with the majority accounting for less than 1% each of the total. On the recipient side, 205 countries and territories have received WaSH aid, with China and India, the largest beneficiaries in nominal terms, accounting together for nearly 19% of the total. During the time period examined in this study, the majority of WaSH aid has been allocated for the construction of large drinking water delivery and sewerage systems; other major activities include aid for basic water supply, water policy development, and waste management.

Historically, the effectiveness of WaSH sector aid has generally been assessed with respect to access to improved sources of drinking water and sanitation in recipient countries, as defined by the JMP. Using access as the benchmark, studies of WaSH aid effectiveness present mixed evidence. Botting *et al.* (2010) conclude that foreign aid has played a role in increasing access to improved sources of drinking water, but has been less effective at expanding access to improved sanitation. Anand (2006) and Bain *et al.* (2013) find no evidence for a correlation between the volume of WaSH aid received and subsequent expanded access to improved sources of drinking water or improved sanitation. Gopalan & Rajan (2016), however, find that WaSH aid does increase access to both improved sources of drinking water and improved sources of sanitation, although they conclude that the effect is limited to middle-income countries and is more pronounced in rural areas than in cities.

Constraints on WaSH aid effectiveness

The vast aid effectiveness literature has identified numerous potential causes of aid ineffectiveness across all sectors (see Doucouliagos & Paldam 2010). In the WaSH sector specifically, Anand (2006) finds that the level of perceived corruption significantly reduces the impact of WaSH aid on increasing access to improved sources. Gopalan & Rajan (2016) suggest that government stability, regulatory quality, and institutional effectiveness may affect WaSH aid effectiveness, but find no empirical evidence, through their use of interaction terms in panel data models, of such an effect. In addition to institutional, political, and economic constraints, the WaSH sector is also potentially subject to technical constraints related to geographical and demographic conditions of a recipient country. These include the size of the rural population, as it has proved challenging to sustainably implement appropriate WaSH delivery in remote areas, as well as environmental scarcity of freshwater in arid regions.

METHODS

Data sources and variables

In the models described below, the WaSH aid variable is constructed as the total per capita dollar value of aid from all donors for WaSH projects, in constant US dollars, committed to a given country-year, summed over 5 years. The use of a moving sum is appropriate in this instance because data from AidData is in the form of commitments; depending on the nature of each aid project, it may take several years for funds to be disbursed and projects implemented. The use of commitments, rather than disbursements, of aid

should also be noted. Although the quality of disbursement data has improved in recent years, it remains limited for many donors. The widely used OECD-DAC dataset, for instance, includes only donor-reported Official Development Assistance (ODA) and has limited coverage for non-OECD donors for much of the time period examined in the present study (see Eichenauer & Reinsberg 2017). Similar limitations are evident in the AidData dataset because disbursements are often not reported in the sources from which AidData is compiled. There is some evidence that commitments and disbursements are sufficiently similar that conclusions regarding aid effectiveness may not be affected by using one measure rather than the other (see Wilson 2011); that the results of this study are largely consistent with those of Gopalan & Rajan (2016), who use aid disbursement data from OECD-DAC, supports this conclusion.

Three indicators were selected as the primary dependent variables against which to measure the effectiveness of WaSH aid. These are: (1) the proportion of the population that reported using an improved source of drinking water, as defined by the JMP (Improved water); (2) the proportion of the population that reported using an improved sanitation facility (Improved sanitation); and (3) the under-five mortality rate, per 1,000 live births (Under-5 mortality). These dependent variables were drawn from the World Bank's World Development Indicators (WDIs). In the models below, both the WaSH aid and the under-five mortality rate variables are expressed as natural logs to account for the dispersion of these variables.

Although the regression models are parsimonious, several control variables are included in each of the models. It is well established that economic development is strongly correlated with better health; wealthier countries tend to have better health care systems, more doctors, and more effective water and sanitation infrastructure (Wilson 2011); as a measure of overall economic productivity, therefore, annual GDP per capita, measured in constant US dollars, is included in each of the models discussed below. Total ODA, measured in per capita, constant dollar terms, is also included to control for any aid-related effects unconnected to the WaSH sector. In the models predicting the under-five mortality rate, the total aid committed to the health sector, as defined by the AidData coding scheme, is included to control for effects from aid funding, for instance, vaccination campaigns, early childhood nutrition, HIV/AIDS prevention, and other initiatives. Finally, the Polity2 score from the Polity IV dataset, which measures the degree of democracy and autocracy in each country, was included as a general measure of regime structure, under the hypothesis that more democratic governments may be more responsive to the health needs of their citizens. The health aid, total ODA, and GDP variables were transformed as natural logs in the regression analysis.

In selecting countries to include in the sample, three income classes were defined using the World Bank definitions of low-income, middle-income, and high-income countries, whereby low-income countries are those with a GNI per capita of less than $1,045; middle-income economies are those with a GNI per capita between $1,045 and $12,746; and high-income countries have a GNI per capita of more than $12,746. The samples used in the regression analysis are based on these definitions, such that the full sample of middle- and low-income countries includes only those countries with a GNI of less than $12,746 per capita, and only for those years in which they met that criterion. The panel covers the years from 1995 through 2014; although AidData includes data on aid commitments dating back to as early as the 1950s, data from earlier in that period are more likely to be incomplete or otherwise inaccurate.

Panel data models

This study relies primarily on three panel data models used previously in the aid effectiveness literature. The first is the Dynamic Panel Model (DPM), an extension of the fixed effects panel regression that accounts for the jointly increasing trends of the variables over time by including both a time variable and the lagged value of the dependent variable, according to the structural equation:

$$y_{i,t} = \beta_0 + \beta_1 x_{i,t} + \beta_2 y_{i,t-5} + \beta_3 t + \alpha_i + \mu_{i,t} \quad (1)$$

where y is the dependent variable, x is the vector of explanatory variables, α is the unobserved country-specific effect, t is a time variable, and $y_{i,t-5}$ is the dependent variable (DV) lagged over 5 years. By including time as an explanatory

variable, this construction accounts for any global 'background' changes in health over time, such as the development and diffusion of new medical technologies, and adjusts for any joint trends among the other variables (Judson & Owen 1999; Wilson 2011).

As an alternative specification, the so-called Latent Growth Model (LGM) was used. This is a variant of the multi-level mixed effects regression in which an independent time variable is estimated for each panel group, in this case individual countries. The model takes the generalized form:

$$y_{i,t} = (\beta_0 + \gamma_{0,i}) + \beta_1 x_{i,t} + (\beta_2 + \gamma_{t,i})(t) + \mu_{i,t} \quad (2)$$

where the term $(\beta_0 + \gamma_{0,i})$ is the country-specific intercept and $(\beta_1 + \gamma_{t,i})(t)$ represents the estimated rate of change over time. This flexible construction allows both random coefficients and random slopes, which is appropriate insomuch as health in recipient countries may begin at different initial states, and change at different rates. No lagged dependent variable is included in the LGM method (see Beck & Katz 2007; Wilson 2011).

Endogeneity is a potential problem in all studies of aid effectiveness. To the extent that donors explicitly target the neediest countries – i.e., those with the lowest levels of access to improved sources of drinking water and sanitation and with the highest child mortality rates – the impact of WaSH aid may be understated in the models. On the other hand, to the extent that donors are concerned with showing results and tend to target countries that have had demonstrated success at expanding services and improving health, then the regression results may mistakenly attribute to WaSH aid those successes. The third model used in this study is a panel instrumental variable model (IVM) designed to account for endogeneity using the form:

$$y_{i,t} = \beta_0 + \beta_1 x_{i,t} + \beta_2 y_{i,t-5} + \beta_3 t + \beta_4 z_{i,t} + \alpha_i + v_{i,t} + \mu_{i,t} \quad (3)$$

where z represents the WaSH aid variable, which, if it is assumed to be endogenous with respect to y, is correlated with the error term v. The equation is estimated using a two-stage least squares procedure, whereby the endogenous variable z is instrumented by an exogenous variable that is correlated with z but not with y. Following Michaeolowa & Weber (2007), aid funds committed to sectors other than the WaSH sector were considered as potential instrumental variables, including the aid for transportation, mining, and energy projects, among others. Among those various sectors, aid for the transportation sector was selected as the best instrument, as it is most highly correlated with WaSH aid ($r = 0.97$).

Subgroup analysis

Past studies of conditional aid effectiveness have relied on the interpretation of interaction terms between, for instance, indices measuring policy conditions and the amount of aid received (e.g., Burnside & Dollar 2000; Gopalan & Rajan 2016). This approach has lent important insight into the conditions under which aid can be effected, but is limited by the availability of data pertaining to the factors that may affect aid effectiveness, such as perceptions of government and institutional quality, which, because they do not vary considerably within countries over time, pose methodological difficulties within the panel framework. This study relies instead on a series of regressions estimated within subgroups of recipient countries, defined based on the presence or absence of potential constraints in those countries during the time period examined. A total of ten potential constraints were identified and tested: these are government ineffectiveness, poor rule of law, poor regulatory quality, low democracy, high autocracy, barriers to international trade, low corruption control, lack of voice and accountability, high rural population, and low freshwater availability. For each constraint, the model was estimated separately for a test group of recipient countries in which the constraint was present and for a control group of countries in which it was not. If the estimated impact of WaSH aid is statistically significant and large among countries in the control group, but insignificant and small in the test group, this would constitute evidence that the constraint is an important determinant of WaSH aid effectiveness.

The presence or absence of the constraint was inferred from the median values of variables from the World Governance Indicators (WGIs), the Polity IV project, and WDIs. For example, countries with an average WGI rule of law score from 1995 to 2014 of less than −0.6 (the median

value for low- and middle-income countries during that time period) were assigned to the test group for that constraint. Similarly, countries with average regulatory quality, government effectiveness, corruption control, or voice and accountability scores of less than the respective median values were assigned to the test group for the applicable constraint. Adopting the definitions of Marshall *et al.* (2002), countries with an average Polity2 score of less than 5 were considered to be non-democratic and those with an average Polity2 score of less than −4 were considered to be autocratic. Following Shamsadìni *et al.* (2010), the test group for barriers to trade includes countries in which foreign trade accounted for less than 50% of GDP, on average. Using the definition of water scarcity cited in Hauge & Ellingsen (1998), the test group for the low water availability constraint includes countries with less than 1,000 cubic meters of available freshwater per person per year, on average. The test group for the high rural population constraint includes countries in which, on average, more than 50% of the total population resided in rural areas.

RESULTS AND DISCUSSION

Is WaSH aid effective?

Table 1 shows the results of the statistical models relating per capita WaSH aid and the three dependent variables of interest for the full sample of low- and middle-income countries. With respect to the overall effectiveness of WaSH aid on health outcomes, the evidence from these regressions is mixed. The WaSH aid variable is significant and negative in the LGM specification, but is insignificant in both the DPM and IVM specifications. The opposite pattern is evident with regards to the role of WaSH aid in increasing the use of improved sources of drinking water and sanitation; the WaSH aid variable is significant (and positive) using the DPM and IVM specification, but insignificant when LGM is applied. Given these inconsistent results, it is not possible to conclude that WaSH aid has been effective in terms of expanding access to improved sources of drinking water and sanitation, or reducing the

Table 1 | Effectiveness of WaSH aid in low-income and middle-income countries

	Child mortality			Improved water source			Improved sanitation		
Model	**DPM**	**LGM**	**IVM**	**DPM**	**LGM**	**IVM**	**DPM**	**LGM**	**IVM**
WaSH aid	−0.003* (0.002)	−0.006*** (0.002)	−0.006 (0.009)	0.137*** (0.022)	−0.012 (0.010)	0.332*** (0.043)	0.072*** (0.022)	−0.019 (0.012)	0.121*** (0.0422)
Health aid	−0.003 (0.002)	0.002 (0.002)	−0.004 (0.007)						
ODA	−0.021*** (0.005)	0.002 (0.003)	−0.020*** (0.005)	0.261*** (0.056)	0.208*** (0.020)	0.235*** (0.057)	0.303*** (0.056)	0.211*** (0.023)	0.297*** (0.056)
GDP	−0.100*** (0.001)	−0.095*** (0.013)	−0.097*** (0.014)	0.621*** (0.123)	−0.489*** (0.084)	0.365*** (0.134)	0.733*** (0.122)	0.056 (0.097)	0.668*** (0.132)
Polity2	−0.010* (0.006)	−0.006 (0.004)	−0.010* (0.006)	0.034 (0.065)	−0.010 (0.023)	0.051 (0.066)	0.045 (0.064)	0.002 (0.027)	0.049 (0.064)
Year	−0.016*** (0.001)	−0.038*** (0.002)	−0.016*** (0.002)	−0.012 (0.014)	0.591*** (0.055)	−0.014 (0.015)	−0.003 (0.0142)	0.502*** (0.048)	−0.004 (0.014)
DV lag	0.604*** (0.015)		0.604*** (0.015)	1.01*** (0.005)		1.01*** (0.006)	0.990*** (0.006)		0.992*** (0.006)
Constant	2.54*** (0.126)	4.85*** (0.125)	2.52*** (0.133)	−5.60*** (1.113)	73.43*** (2.018)	−4.16*** (1.164)	−5.97** (1.08)	51.7*** (2.12)	−5.65*** (1.16)
N	2,428	2,428	2,428	2,428	2,428	2,428	2,428	2,428	2,428
R squared	0.957		0.957	0.977		0.977	0.992		0.992

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Standard errors in parentheses.

disease burden among the full population of recipient countries.

Among the covariates in these initial regressions, GDP per capita is consistently statistically significant and negative, supporting the hypothesis that wealthier countries are more likely to use improved WaSH facilities and to experience lower child mortality rate. The amount of total aid received is generally significant and has a positive effect on health outcomes (i.e., the coefficient is positive in the models predicting the use of improved sources of drinking water and sanitation and negative in the models predicting child mortality). Consistent with Wilson (2011) results, however, there does not appear to be any evidence for an impact of aid in the health sector on the child mortality rate in the full sample.

Constraints on WaSH aid effectiveness

The non-finding regarding the effectiveness of aid in the WaSH sector is consistent with the premise that aid's impact is heterogeneous across different categories of recipient countries. As shown in Table 2, the WaSH aid variable is a negative and highly statistically significant predictor of child mortality – meaning that the amount of WaSH aid received tended to reduce child mortality – in all three of the model specifications when the sample includes only country-years meeting the World Bank definition of middle-income countries; among low-income and high-income countries, however, the WaSH aid variable is insignificant.

The pattern holds true with regard to the use of improved sources of drinking water and improved sources of sanitation; across all of the models, WaSH aid appear to be effective in the middle-income sample. There are several potential explanations for why WaSH aid is more effective in middle-income than in low-income countries. It may be the case that the former are more likely than the latter to have in place effective institutions that allow for the more efficient absorption of aid funds (Bigsten & Tengstam 2015). These countries may be more economically open and thus better placed to take full advantage of international partnerships for development (Shamsadìni *et al.*

Table 2 | WaSH aid effect on under-five mortality rate by recipient country income level

	Low-income countries			Middle-income countries			High-income countries		
	DPM	LGM	IVM	DPM	LGM	IVM	DPM	LGM	IVM
WaSH aid	0.008*	0.005	0.027	−0.007***	−0.012***	−0.022**	−0.004	0.010**	0.245*
	(0.004)	(0.006)	(0.022)	(0.003)	(0.003)	(0.010)	(0.003)	(0.004)	(0.146)
Health aid	−0.003	−0.001	−0.039***	−0.001	−0.001	0.009	0.005	0.012**	−0.208
	(0.003)	(0.005)	(0.015)	(0.002)	(0.003)	(0.008)	(0.004)	(0.005)	(0.139)
ODA	−0.033***	0.010	−0.026***	−0.007	0.007	−0.004	0.005*	0.002	0.004
	(0.008)	(0.011)	(0.010)	(0.007)	(0.009)	(0.007)	(0.002)	(0.003)	(0.008)
GDP	−0.010***	−0.255***	−0.132***	−0.128***	−0.245***	−0.111***	−0.017	−0.052**	−0.008
	(0.019)	(0.025)	(0.024)	(0.018)	(0.022)	(0.021)	(0.015)	(0.020)	(0.049)
Polity2	−0.018**	−0.0128	−0.010	0.001	0.0003	0.0002	0.015*	0.006	−0.015
	(0.009)	(0.0121)	(0.010)	(0.009)	(0.010)	(0.008)	(0.008)	(0.011)	(0.031)
Year	−0.040***	−0.034***	−0.012***	−0.017**	−0.033***	−0.018***	−0.011***	−0.034**	−0.007
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.006)
DV lag	0.720***		0.729***	0.538***		0.531***	0.657***		0.423***
	(0.023)		(0.026)	(0.019)		(0.019)	(0.024)		(0.153)
Constant	30.2***	73.8***	26.8***	36.6***	71.8***	38.5***	21.75***	71.8***	15.7***
	(4.00)	(5.246)	(4.747)	(3.726)	(4.46)	(4.02)	(3.90)	(4.75)	(13.2)
N	1,025	1,025	1,025	1,403	1,403	1,403	974	974	974
R squared	0.914		0.905	0.910		0.910	0.977		0.575

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Standard errors in parentheses.

2010). They may tend to be more democratic, less corrupt, or otherwise more responsive to the development needs of their populations (Kosack 2003; Knack & Rahman 2007; Doucouliagos & Paldam 2010). Alternatively, the poorest and neediest countries may tend to face technical and environmental constraints not present in wealthier nations that affect both their relative need and the potential impact of aid (Wayland 2017).

To test the role of each of the potential economic, political, institutional, and technical constraints on WaSH aid effectiveness, the statistical models were estimated within a series of subgroups based on the presence or absence of potential constraints, as described above. For each set of test and control groups, nine regression models were estimated, corresponding to the three alternative model specifications and the three dependent variables. The results were similar with respect to the significance of the WaSH aid variable across the three model specifications. To facilitate comparison between the groups, Table 3 below reports only the coefficient of the WaSH aid variable from the IV regression models.

Among the potential constraints, government ineffectiveness, poor regulatory quality, and large rural population have the strongest evidence suggesting that they limit the effect of WaSH aid on child mortality. For these constraints, the WaSH aid variable is consistently insignificant in the sample of countries in which the constraint was present and is consistently significant in the sample of countries in which it was absent.

The WGI dataset measures government effectiveness in terms of perceptions of the quality of public services, the quality of the civil service, the degree of independence of the civil service from political pressure, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Regulatory quality measures perceptions of the ability of the

Table 3 | Coefficient of WaSH aid variable on under-five mortality rate in countries with and without potential constraints on effectiveness (instrumental variable model)

	Countries with constraint (test group)			Countries without constraint (control group)		
Constraint	**Under-5 mortality**	**Improved water**	**Improved sanitation**	**Under-5 mortality**	**Improved water**	**Improved sanitation**
Low democracy (Polity2 score <5)	0.006 (0.010)	0.254*** (0.066)	0.194*** (0.076)	−0.009 (0.008)	0.360*** (0.070)	0.040 (0.041)
High autocracy (Polity2 score < −4)	0.023* (0.014)	0.359*** (0.125)	0.417** (0.185)	−0.003 (0.011)	0.255*** (0.051)	0.057 (0.036)
Closed to trade (Trade <50% of GDP)	0.016 (0.018)	0.067 (0.106)	−0.225 (0.169)	−0.006 (0.011)	0.279*** (0.053)	0.154*** (0.051)
Poor rule of law (Rule of law score < −0.6)	−0.013 (0.011)	0.192** (0.090)	0.042 (0.034)	−0.067*** (0.024)	0.105*** (0.032)	0.128** (0.050)
Ineffective governance (Effectiveness score < −0.5)	0.003 (0.011)	0.082 (0.092)	0.0419 (0.043)	−0.072*** (0.017)	0.146*** (0.042)	0.043*** (0.016)
Low corruption control (Corruption control score < −0.5)	0.001 (0.012)	0.133*** (0.030)	0.024 (0.0297)	−0.084** (0.035)	0.084*** (0.021)	0.112*** (0.025)
Poor regulatory quality (Regulatory quality score < −0.4)	0.003 (0.006)	0.083 (0.085)	0.090 (0.071)	−0.016** (0.008)	0.165*** (0.043)	0.121*** (0.048)
Poor voice and accountability (Accountability score < −0.5)	0.015 (0.011)	0.135 (0.096)	0.158*** (0.070)	−0.009 (0.017)	0.408*** (0.063)	0.012 (0.053)
Low water availability (<5,000 m^3 freshwater per capita)	0.005 (0.010)	0.339*** (0.073)	0.194*** (0.070)	−0.050*** (0.011)	0.299*** (0.063)	0.026 (0.055)
Large rural population (Rural population >50%)	0.003 (0.014)	0.429 (0.790)	0.094 (0.086)	−0.072*** (0.019)	0.158*** (0.054)	0.162*** (0.048)

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Standard errors in parentheses.

government to formulate and implement sound policies and regulations that permit and promote private sector development. Taken together, therefore, the results suggest that WaSH aid is less likely to contribute to positive outcomes in recipient countries wherein drinking water supply and sanitation is managed or regulated by ineffective or unresponsive bureaucracies. They also suggest that countries with large rural populations are less likely to benefit from WaSH aid, an effect that is likely due to the widely observed difficulties in extending WaSH services to rural communities (World Health Organization 2015; Fuller *et al.* 2016).

CONCLUSION

This paper contributes to an emerging literature investigating the conditions under which specific categories of foreign aid can be effective in producing positive development outcomes in recipient countries. The findings presented above support recent studies that have found evidence that some sectors of foreign aid, such as the WaSH sector, contribute to sector-specific development goals. These studies stand in contrast to decades of research testing the aggregate effect of foreign aid on economic growth, which has been generally inconclusive – though largely negative – regarding the utility of aid as a tool for promoting development (Doucouliagos & Paldam 2011). The results presented above constitute evidence that aid in the WaSH sector has contributed to expanding access to improved sources of water and sanitation, and reduced disease burden in some, but not all, recipient countries. Specific types of institutional weakness and governmental policies are identified that tend to reduce aid's impact, including especially bureaucratic effectiveness and regulatory quality. The proportion of the population of recipient countries that resides in rural areas also appears to affect the impact of WaSH aid.

The major contribution of this study is the identification and testing of specific factors that affect the relationship between WaSH aid funds and sector-specific outcomes. The results support the conclusions of Gopalan & Rajan (2016) that the effectiveness of aid in the WaSH sector differs among recipients as a function of institutional, economic, and demographic characteristics. Contrary to the findings of those authors, the proportion of the population of recipient countries that resides in rural areas also appears to affect the effectiveness of WaSH aid; among countries with a majority rural population, there is no evidence of a relationship between WaSH aid and increased use of improved WaSH facilities or reduced mortality. Consistent with the poverty trap literature as it applies to aid effectiveness generally (see Simplice 2014), poor economic performance appears to be a major constraint on WaSH aid effectiveness. As discussed by Ndikumana & Pickbourn (2017) in the specific context of the WaSH sector, low income and stagnant growth may constrain the ability of households to pay for services, threatening the long-term sustainability of water and sanitation provision, while financial constraints on the public sector may undermine the effectiveness of monitoring and evaluation of WaSH sector projects (see also Gopalan & Rajan 2016).

Although studies such as the present one are useful for identifying the characteristics of developing countries that are in the position to use WaSH aid effectively, there is a pressing need for future research to investigate the extent to which aid can be used, in countries that possess the major constraints on aid effectiveness, to remove these constraints by building recipient country capacity. A future research initiative is recommended to examine the effectiveness of foreign aid for capacity building in recipient countries, whether in the WaSH sector or more generally, and to identify the specific activities that aid donors and their recipient partners can engage in to remove or ameliorate the constraints on aid effectiveness.

REFERENCES

Anand, P. B. 2006 Making services work for the poor: An examination of effectiveness of aid in water and sanitation sector. In: *Paper Presented at the UNU-WIDER Conference on Aid*, Helsinki, Finland, June 2006.

Bain, R., Luyendijk, R. & Bartram, J. 2013 Universal access to drinking water: The role of aid, UNU-WIDER Working Paper No. 2013/88. In: *World Institute for Development Economic Research (UNUWIDER)*, Helsinki, Finland, September 2013.

Beck, N. & Katz, J. N. 2007 Random coefficient models for time-series–cross-section data: Monte Carlo experiments. *Political Analysis* **15** (2), 182–195.

Bigsten, A. & Tengstam, S. 2015 International coordination and the effectiveness of aid. *World Development* **69**, 75–85.

Botting, M. J., Porbeni, E. O., Joffres, M. R., Johnston, B. C., Black, R. E. & Mills, E. J. 2010 Water and sanitation infrastructure for health: the impact of foreign aid. *Globalization and Health* **6** (1), 12–20.

Burnside, C. & Dollar, D. 2000 Aid, policies, and growth. *American Economic Review* **90** (4), 847–868.

Doucouliagos, H. & Paldam, M. 2010 Conditional aid effectiveness: a meta-study. *Journal of International Development* **22** (4), 391–410.

Doucouliagos, H. & Paldam, M. 2011 The ineffectiveness of development aid on growth: an update. *European Journal of Political Economy* **27** (2), 399–404.

Eichenauer, V. Z. & Reinsberg, B. 2017 What determines earmarked funding to international development organizations? Evidence from the new multi-bi aid data. *The Review of International Organizations* **12** (2), 171–197.

Fuller, J. A., Goldstick, J., Bartram, J. & Eisenberg, J. N. 2016 Tracking progress towards global drinking water and sanitation targets: a within and among country analysis. *Science of the Total Environment* **541**, 857–864.

Gopalan, S. & Rajan, R. S. 2016 Has foreign aid been effective in the water supply and sanitation sector? Evidence from panel data. *World Development* **85**, 84–104.

Hauge, W. & Ellingsen, T. 1998 Beyond environmental scarcity: causal pathways to conflict. *Journal of Peace Research* **35** (3), 299–317.

Hicks, R. L., Parks, B. C., Roberts, J. T. & Tierney, M. J. 2008 *Greening Aid? Understanding the Environmental Impact of Development Assistance.* Oxford University Press, Oxford.

Judson, R. A. & Owen, A. L. 1999 Estimating dynamic panel data models: a guide for macroeconomists. *Economics Letters* **65** (1), 9–15.

Knack, S. & Rahman, A. 2007 Donor fragmentation and bureaucratic quality in aid recipients. *Journal of Development Economics* **83** (1), 176–197.

Kosack, S. 2003 Effective aid: how democracy allows development aid to improve the quality of life. *World Development* **31** (1), 1–22.

Marshall, M. G., Gurr, T. R., Davenport, C. & Jaggers, K. 2002 Polity IV, 1800-1999 comments on Munck and Verkuilen. *Comparative Political Studies* **35** (1), 40–45.

Michaelowa, K. & Weber, A. 2007 Aid effectiveness in the education sector: A dynamic panel analysis. In: *Theory and Practice of Foreign Aid* (S. Lahiri, ed.), Elsevier, Amsterdam, pp. 357–385.

Ndikumana, L. & Pickbourn, L. 2017 The impact of foreign aid allocation on access to social services in sub-Saharan Africa: the case of water and sanitation. *World Development* **90**, 104–114.

Shamsadìni, S., Moghaddasi, R. & Kheirandish, M. 2010 Relationship between trade openness and GDP growth: a panel data analysis. *World Applied Sciences Journal* **8** (7), 906–911.

Simplice, A. 2014 Development thresholds of foreign aid effectiveness in Africa. *International Journal of Social Economics* **41** (11), 1131–1155.

Tierney, M. J., Nielson, D. L., Hawkins, D. G., Roberts, J. T., Findley, M. G., Powers, R. M., Parks, B., Wilson, S. E. & Hicks, R. L. 2011 More dollars than sense: refining our knowledge of development finance using AidData. *World Development* **39** (11), 1891–1906.

Wayland, J. 2017 Constraints on aid effectiveness in the water, sanitation, and hygiene (WASH) sector: evidence from Malawi. *African Geographical Review*. doi: 10.1080/19376812.2017.1340169.

Wilson, S. E. 2011 Chasing success: health sector aid and mortality. *World Development* **39** (11), 2032–2043.

World Health Organization 2015 *Progress on Sanitation and Drinking Water: 2015 Update and MDG Assessment.* World Health Organization, Geneva.

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