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The Impact of Foreign Aid Allocation on Access to Social Services in sub-Saharan Africa: The Case of Water and Sanitation

LÉONCE NDIKUMANA [a] and LYNDA PICKBOURN [b,*]

[a] *University of Massachusetts at Amherst, USA*
[b] *Hampshire College, USA*

Summary. — The Sustainable Development target of ensuring access to water and sanitation for all by 2030 has far-reaching implications for the achievement of the other SDGs. However, achieving this target remains a major challenge for sub-Saharan Africa, and the ability of governments in the region to expand access is constrained by limited financial resources. This paper investigates whether targeting foreign aid to the water and sanitation sector can help achieve the goal of expanding access to water and sanitation services in sub-Saharan Africa. The analysis is based on panel data estimation techniques controlling for country-specific effects and potential endogeneity of regressors. The econometric results suggest that increased aid targeted to the supply of water and sanitation is associated with increased access to these services, although the relationship is non-linear. The evidence in this study makes an important contribution to the scholarly debate on aid effectiveness. It also has important practical implications for aid policy: specifically, it suggests that in addition to scaling up aid disbursements to sub-Saharan African countries, donors need to increase aid allocation to water and sanitation as well as other areas where the region lags behind. There is also a need to identify structural constraints that may limit access to water and sanitation, and utilize foreign aid so as to alleviate these constraints.

Key words — water, sanitation, official development aid, sub-Saharan Africa, poverty

1. INTRODUCTION

Access to social services—education, health care, potable water, adequate sanitation—is vital to securing and sustaining human development, reducing poverty, and achieving other development goals (United Nations, 2013). However, while education and health care have received significant attention from governments and from bilateral and multilateral donors, less attention has been paid to the provision of water and sanitation in the allocation of aid, in policy debates, and in the scholarly literature. In sub-Saharan Africa (SSA), this is reflected in the uneven nature of progress made toward achieving the different United Nations' Millennium Development Goals (MDGs). While the region appears to have made progress in improving health and education outcomes, the provision of safe drinking water and basic sanitation remains a major challenge. When the term of the MDGs expired in 2015, only a handful of countries in the region had succeeded in halving the proportion of people without access to safe drinking water, and none had been able to meet the sanitation target (UNICEF and WHO, 2015). The WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation estimates that 32% of the population in sub-Saharan Africa—about 319 million people—do not have access to an improved drinking water source, while 70%—about 695 million people—lack access to improved sanitation facilities (UNICEF and WHO, 2015). There is also a significant rural–urban gap: only 56% of the rural population has access to improved water sources, compared to 87% of the urban population. Similarly, only 23% of the rural population has access to improved sanitation facilities, compared to 40% of the urban population (UNICEF and WHO, 2015). However, progress in increasing urban access also appears to have stagnated: during 1990–2015, urban access to sanitation went up by only 1% while urban access to water increased by only 4% (UNICEF and WHO). More worryingly, the proportion of urban dwellers with access to piped water in their homes declined from 43% to 34% (Hopewell & Graham, 2014). There are also significant disparities by income: 64% of the poorest quintile of urban residents have access to improved water supply compared with 94% of the wealthiest quintile, while 42% of the poorest quintile have access to improved sanitation facilities compared to 91% of the wealthiest quintile (Hopewell & Graham, 2014). With the adoption of the Sustainable Development Goals (SDGs) in 2015, it remains to be seen whether sub-Saharan Africa will be able to achieve Goal Six—to ensure access to water and sanitation for all by 2030.

Expanding access to water and sanitation is a goal that has far-reaching implications for the achievement of the other SDGs. Access to clean drinking water and sanitation is directly linked to health outcomes, especially for infants and children. Despite some gains in reducing child mortality, SSA still has the highest under-five mortality rate (at 98 deaths per 1000) and is the only region to have reduced the rate by less than half during 1990–2011 (World Bank, 2014). Worldwide, diarrheal diseases, most commonly caused by gastrointestinal infections and transmitted through the oral-fecal route are the most common cause of childhood deaths (Botting & *et al.*, 2010). Frequent occurrences of diarrhea and other diseases resulting from lack of access to water and sanitation undermine human capital formation and reduce the productivity of adults who fall sick or must care for the sick. Therefore, increasing access to water and sanitation can help to improve both health outcomes and human capital, thus contributing to greater overall productivity.

Inadequate access to clean water sources and sanitation also has implications for SDG five, i.e., achieving gender equality (especially in the areas of education and labor force participation) and empowering women and girls. In many SSA

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countries, women and girls are responsible for fetching water and caring for the sick (WHO and UNICEF, 2008). Inadequate supply of water and sanitation infrastructure not only increases the time it takes to fetch water, but by increasing the risk of illness, it also increases the time that women spend on unpaid care of family members. Furthermore, limited access to water and sanitation increases the likelihood that girls will be withdrawn from school to help fetch water, and reduces the time that women can allocate to paid market work. SSA continues to lag behind other regions in lowering the gap in male–female enrollment ratios at all levels of education, and girls remain at a significant disadvantage in access to primary and secondary education (United Nations, 2013). Efforts to narrow the gender gaps in education and paid employment, which tend to be significantly higher in rural areas, will continue to be hampered by the lack of access to potable water and improved sanitation.

Improving access to water and sanitation should therefore be a top priority in the SSA region. However, the lack of financing remains an important constraint on the ability of governments to expand and maintain water and sanitation infrastructure, and efforts to expand access to water and sanitation have focused on mobilizing more financial resources, both domestically and through increased aid inflows to bridge the financing gaps in the provision of water and sanitation services. In recognition of this, donors at the G-8 summit of 2005 committed to doubling aid to the continent to improve the delivery of public services and build infrastructure for health, education, water and sanitation (Wolf, 2007). However, despite having increased from a low of 2.8% in 2002 to 4.1% in 2008, the share of total aid going to the water and sanitation sector in sub-Saharan Africa remains low relative to other regions and in comparison with aid to other sectors such as education (Salami, Stampini, Kamara, Sullivan, & Namara, 2011; Wolf, 2007). Moreover, simply increasing the volume of total aid to the region without targeting the water and sanitation sectors may not lead to expanded access to these services, since water and sanitation compete with other public services for funding, and physical infrastructure such as roads tend to be higher on governments' priority lists.

In this paper, we use an unbalanced panel data set from a sample of 29 sub-Saharan African countries over the 1990–2010 period to investigate whether targeting foreign aid to the water and sanitation sector can help achieve the goal of expanding access to water and sanitation services. Specifically, we use OECD/DAC data on aid disbursements to examine the impact of foreign aid targeted to water and sanitation on the share of the rural and urban populations with access to these social services. Because of the wide rural–urban inequalities in access to water and sanitation in sub-Saharan Africa, we also examine the impact of aid to the sector on the urban–rural gap in access to these services. The rural–urban gap is measured by the ratio of the percentage of the rural population with access to water and sanitation to the percentage of the urban population with access to these services.

In the remainder of the paper, we provide a literature review in the next section. Section 3 is devoted to the empirical analysis, with a description of the data and the empirical model, and a discussion of the regression results. Section 4 concludes.

2. LITERATURE REVIEW

Efforts to expand access to social services such as water and sanitation in Africa have typically focused primarily on mobilizing additional financial resources and much less on how the allocation of resources across various uses helps achieve development goals. This is an important part of the fundamental problem encountered in the assessment of the effectiveness of foreign aid, which has largely relied on aggregate data to identify the linkages between foreign aid and economic outcomes, with conflicting results (Doucouliagos & Paldam, 2009; McGillivray, Feeny, Hermes, & Lensink, 2006). The difficulty of documenting the impact of foreign aid at the macro level has led to a growing body of work that highlights the importance of focusing analysis of aid effectiveness at the sectoral level (Lee & Izama, 2015; Michaelowa & Weber, 2006; Ndikumana, 2012; Nunnenkamp & Öhler, 2011; Williamson, 2008; Wilson, 2011). Evidence from a number of studies that focus on the impact of aid on sector-specific outcomes suggests that targeted aid interventions can achieve positive results at the micro level (Dreher, Nunnenkamp, & Thiele, 2008; Gyimah-Brempong, 2015; Mishra & Newhouse, 2009; Pickbourn & Ndikumana, 2016; Yogo & Mallaye, 2015).

To the best of our knowledge, only a handful of other studies have examined the impact of aid disbursements to the water and sanitation sector on access to these services in developing countries, with conflicting results. Using OLS regression analysis of cross-sectional data to model public service production functions in 110 developing countries for a single year, Wolf (2007) finds that the share of total aid committed to the water and sanitation sector in 2000 has no impact on access to sanitation, and a negative impact on access to water in 2002. [1] In contrast, using Spearman's rank correlation coefficients for a group of 48 countries, Botting *et al.* (2010) find that low-income countries receiving the most aid to the water and sanitation sector are 4–18 times more likely than countries in the lowest tercile of foreign aid to achieve greater gains in population access to water over the period 2002–06. However, this effect disappears when they control for GDP, public health expenditure and land area. Using OLS on data from 31 cities in sub-Saharan Africa, Hopewell and Graham (2014) find no significant association between ODA allocated to water supply and sanitation (large systems) over 2000–10 and access to water and sanitation, although they do find a negative and significant association between their measure of aid and the prevalence of open defecation. The methods used in these studies preclude any consideration of the effect of possible endogeneity of the regressors and time-invariant country-specific variables. These limitations are to some extent addressed by Wayland (2013) who, using fixed-effects regressions on panel data covering 50 years and 133 countries, finds that increased aid commitments to the water and sanitation sector are associated with increased access to improved water sources. The study does not explore the impact of aid on access to improved sanitation facilities. More recently, using fixed-effects regressions on panel data covering 20 years and 114 countries, Bain, Luyendijk, and Bartram (2013) do not find any significant effect of aid disbursements to water and sanitation on improved water and sanitation coverage over the period 2000–10. Like the previous studies, Bain *et al.* (2015) specify a linear relationship between aid to the water and sanitation sector and access to these services.

This paper adds to the growing empirical literature on aid effectiveness at the sectoral level by extending and deepening the coverage of existing studies on aid and access to water and sanitation by focusing specifically on access to water and sanitation in sub-Saharan Africa. Using both fixed effects regressions and the generalized method of moments (system GMM) regressions, we are able to take into account the effects of omitted country-specific time-invariant variables as well as potential endogeneity of regressors. Furthermore, our

specification allows for the possibility of non-linearities or threshold effects in the relationship between aid to the water and sanitation sector and access to these services. Threshold effects in the impact of aid have two dimensions: vertical or within-country as aid increases over time, and horizontal or across–country due to differences in the amount of aid received. In the presence of significant cross-country variations in aid disbursements, a quadratic specification may be more appropriate than the linear specifications used in other studies. In addition, we explore the impact of aid on the rural–urban gap in access to water and sanitation. Given the observed high inequalities in African countries along monetary and non-monetary dimensions of social development, progress in reducing the rural–urban gap may be a more pressing objective than increasing the average national access rate.

3. EMPIRICAL ANALYSIS

(a) *Data and stylized facts*

This study uses data on official aid disbursements at the project level from the OECD Creditor Reporting System (CRS) database. Despite criticisms that this database under-reports the amount of aid given to developing countries by excluding aid from non-OECD donors (Tierney *et al.*, 2011), we find that it has the most complete information on actual disbursements of aid. Aid from all donors is aggregated to obtain total aid as well as aid targeted to the water and sanitation sector by recipient country. Data on access to water and sanitation are taken from the World Bank's World Development Indicators (WDI). Country-level social and economic indicators used as control variables in the econometric analysis are also taken from WDI. A governance indicator used to control for the impact of institutions on service delivery is obtained from the International Country Risk Guide (ICRG). Data on the main variables, the indicators of access to improved water and sanitation facilities, as defined by the UNICEF-WHO Joint Monitoring Program for Water Supply and Sanitation, are available only from 1990. Therefore the sample period is 1990–2010. The list of regression variables, their definition and data sources are given in Table 8 in the Appendix, and summary statistics are reported in Table 1.

The data show that sub-Saharan Africa lags behind all other regions in terms of access to water and sanitation (Table 2). On average, only about 57% of the rural population in the region has access to an improved source of water, compared with 85.5% of the region's urban population. There are also disparities in access to sanitation, with only 28.7% of the rural population having access to improved sanitation, compared with 51% of the urban population. There are large cross-country variations and rural–urban disparities in access to water and sanitation (Table 3). Ethiopia has the largest rural–urban gap in access to water, followed by South Africa and Madagascar, while Eritrea has the largest rural–urban gap in access to sanitation (Table 3).

Table 2. *Regional disparities in access to water and sanitation, 1990–2010*

	Sub-Saharan Africa	Other developing regions
Percentage of population with access to water		
Rural	57.1	79.6
Urban	85.5	94.1
Total	67.6	86.7
Percentage of population with access to sanitation		
Rural	28.7	66.5
Urban	51.0	83.2
Total	36.9	74.6

Source. OECD/DAC Country Reporting System; World Development Indicators; International Country Risk Guide (ICRG).

Aid to the water and sanitation sector averaged around 5% of total aid to the region during 1990–2010. As a share of GDP, aid to the water and sanitation sector in the countries in our sample began to increase after 2000 (Figure 1). However, the share of total aid going to water and sanitation has been on the decline since 1980, in comparison with humanitarian aid and aid going to population services, civil society, and health (Figure 2). During 1990–2010, the water and sanitation sector received a smaller share of total aid than education, agriculture, humanitarian services and infrastructure (Figure 3).

(b) *Model specification and estimation methodology*

The impact of foreign aid on access to water and sanitation is investigated by estimating two versions of a baseline model. The first version of the model relates the percentage of the population (rural and urban, alternatively) with access to improved water sources or improved sanitation facilities to aid disbursements to the water and sanitation sector as a whole, controlling for other determinants of access to these services. We use total aid to the sector rather than aid by sub-sector because access to water and access to sanitation are likely to be interdependent, and aid to one sub-sector is likely to have an impact on access in the other subsector. In particular, improvements in water infrastructure may facilitate access to improved sanitation, either because communities willingly engage in sanitation programmes when their primary need for water has been met, or because access to water

Table 1. *Summary statistics for regression variables, 1990–2010*

Variable	Mean	Median	Standard deviation	Minimum	Maximum
Access to water (share of rural population)	54.1	51	21.4	5.1	99.0
Access to sanitation (share of rural population)	27.1	18	24.9	1.0	94.0
Ratio of urban access to rural access (water)	1.8	1.4	1.2	0.9	15.8
Ratio of urban access to rural access (sanitation)	3.8	2	4.8	0.9	57
Aid disbursement to water and sanitation sector (% of GDP)	0.5	0.26	0.9	0.0	11.04
Log GDP per capita	6.1	5.8	1.04	3.9	9.1
Age dependency ratio	85.8	87.9	12.4	40.4	107.5
Adult female literacy rate (% of female population aged 15 and above)	53.8	55.2	25.8	4.5	99.5
Public health expenditure (% of GDP)	2.7	2.23	2.04	0.003	19.2
Government stability index (1 = mostly stable, 0 = mostly unstable)	0.6	0.67	0.2	0.05	0.9

Source. OECD/DAC Country Reporting System; World Development Indicators; International Country Risk Guide (ICRG).

Table 3. *Percentage of the population with access to water and sanitation in SSA, average over 1990–2010*

Country	Access to water		Access to sanitation	
	Total	Urban/Rural ratio	Total	Urban/Rural ratio
Angola	45.9	1.33	42.5	7.51
Burundi	71.3	1.28	45.2	1.02
Benin	66	1.34	9.1	8.89
Burkina Faso	60.1	1.59	11.7	13.9
Botswana	94.9	1.11	51.3	2.2
Central African Republic	62.6	1.73	22.3	2.35
Cote D'Ivoire	77.7	1.35	21.7	3.91
Cameroon	63.9	2.07	48.6	1.65
Congo, Republic of	70.7	2.74	19.1	1.22
Comoros	91.8	1.03	27.9	1.98
Cape Verde	83.4	1.05	46.6	2.39
Djibouti	82.6	1.44	59	3
Eritrea	51.9	1.43	11.2	26.3
Ethiopia	28.9	6.6	9.76	9.19
Gabon	85.6	2.11	34.7	1.21
Ghana	70.2	1.59	10.2	2.69
Guinea	63.1	1.75	14.2	2.94
Gambia	82.8	1.17	63.7	1.11
Guinea Bissau	50.2	1.58	15.5	6.83
Equatorial Guinea	51	1.57	89	1.06
Kenya	51.4	2.09	28.4	1.04
Liberia	63.9	1.46	13.2	7.78
Lesotho	79.4	1.23	25.2	1.61
Madagascar	37.7	3.33	12	1.88
Mali	45.9	2.03	18.3	2.84
Mozambique	41.7	2.75	14.2	8.63
Mauritania	40.3	1.21	20.9	4.41
Mauritius	99	1.01	89	1.03
Malawi	62.4	1.72	45.2	1.1
Namibia	80.2	1.42	28.1	4.74
Niger	42.1	2.22	6.95	9.29
Nigeria	53.3	2.15	34	1.18
Rwanda	66	1.35	46.3	1.39
Sudan	79.6	1.26	81.8	1.08
Senegal	65.9	1.85	44.9	2.21
Sierra Leone	46.5	2.47	11.4	4.37
Somalia	69.5	1.45	30.5	5.44
São Tomé and Principe	81.4	1.17	22.8	1.77
Swaziland	90.1	1.3	81.4	1.38
Chad	45.2	1.46	10.3	4.83
Togo	58.4	1.44	40.9	1.8
Tanzania	62.4	1.81	91.2	1.04
Uganda	93.9	1.02	82.5	1.1
South Africa	23.3	4.38	22	5.57
Congo, Democratic Rep.	44.5	3.14	16.1	2.57
Zambia	54.4	2.61	46.9	1.47
Zimbabwe	79.7	1.41	40.3	1.56

Source. OECD/DAC Country Reporting System; World Development Indicators; International Country Risk Guide (ICRG).

directly facilitates the use of water-reliant sanitation systems, especially in urban areas.[2] The first version of the model is specified as follows:

$$Access_{s,it} = b_0 + \theta Aid_{it} + \lambda Aid_{it}^2 + \mathbf{Z}'_{it}\Gamma + u_i + \omega_{it} \quad (1)$$

where the subscripts i, t, and s denote the country, time, and sector (water or sanitation). *Access* is the share of the population (rural and urban, alternatively) that has access to improved drinking water or sanitation, *Aid* is foreign aid disbursements targeted to the water and sanitation sector as a percentage of GDP, Aid^2 is *Aid* squared, which captures possible non-linearities in the relationship between foreign aid disbursements and access to water or sanitation, $\mathbf{Z}$ is a vector of control variables consisting of determinants of access to water and sanitation other than aid, u is a term that accounts for unobserved country-specific factors, and ω is a random error term.[3] An example of an important unobserved country-specific factor that may affect access to water and sanitation is geography. The supply of water and sanitation facilities is likely to be more costly in a country with a rugged terrain and low population density. An arid or semi-arid country also faces higher costs of provision of water and sanitation than countries with adequate rainfall and rich water reserves in rivers and lakes.

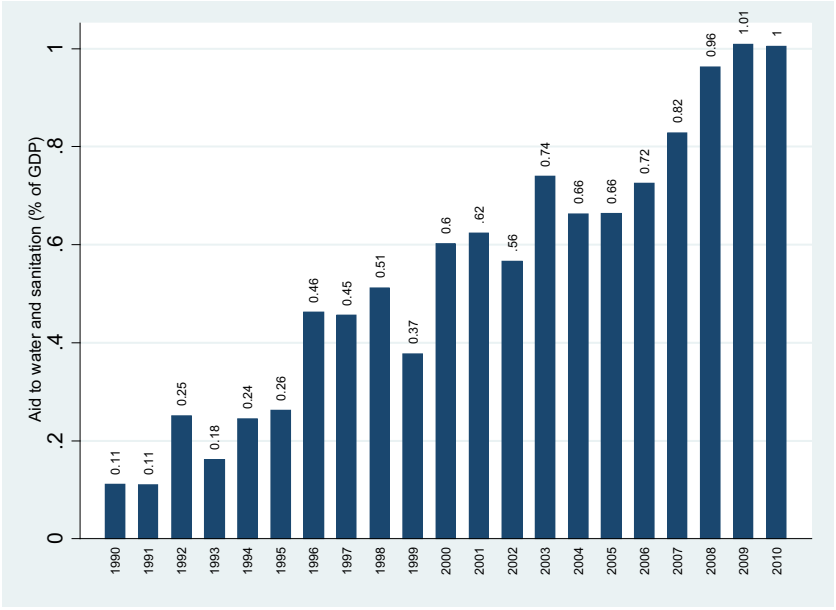

Figure 1. *Foreign aid to the water and sanitation sector in SSA (% of GDP), 1990–2010.*

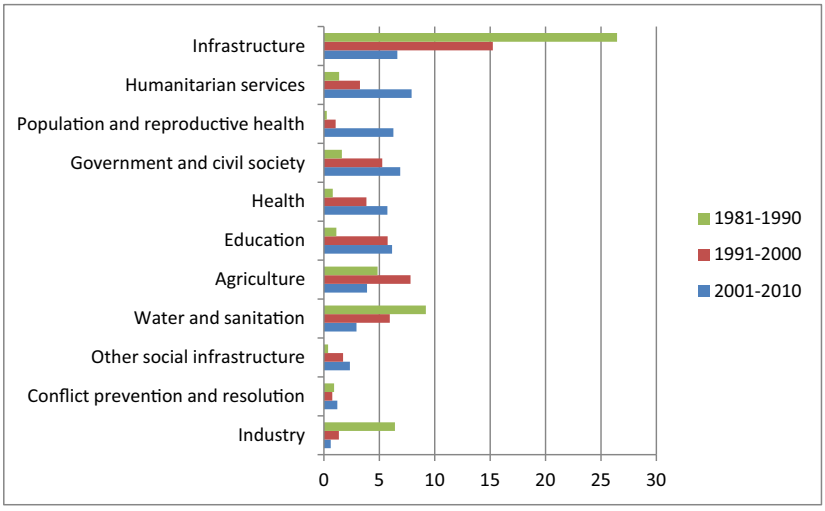

Figure 2. *Changes in sectoral aid allocation, 1981–2010.*

The second version of the model is specified to investigate the impact of aid disbursements to the water and sanitation sector on rural–urban disparities in access to water and sanitation. The model is specified as:

$$AccessRatio_{s,it} = b_0 + \psi Aid_{it} + \phi Aid_{it}^2 + \mathbf{Z}_{it}'\Gamma + u_i + \omega_{it} \qquad (2)$$

where $AccessRatio_{s,it}$ denotes the ratio of the percentage of the urban population to the percentage of the rural population with access to water or sanitation in country i in year t. The other terms in Eqn. (2) have the same meanings as in Eqn. (1).

The control variables included in the analysis are: the log of real GDP per capita, the age dependency ratio, the female literacy rate, government health expenditure as a percentage of GDP, and governance measured by a government stability index. GDP per capita measures both the government financing capacity and the public's effective demand for water and sanitation services. Government health expenditure measures both the government's capacity and commitment to providing social services. These two variables are expected to be positively correlated with access to water and sanitation. The female literacy rate, which tends to be positively correlated with the overall literacy rate, captures not only the extent of gender equality but also the demand for social services, including capacity to exert political pressure on the government. This indicator is therefore expected to be positively related to access to water and sanitation. The age dependency ratio accounts for both demand for services and pressure on public resources for alternative needs. In the context of limited public resources as is typical in all SSA countries, a high dependency ratio is expected to be negatively associated with access to water and sanitation. The governance indicator is a proxy for both commitment and effectiveness of the government in delivering social services. We also include a dummy variable for the post-2000 period to capture the observed acceleration

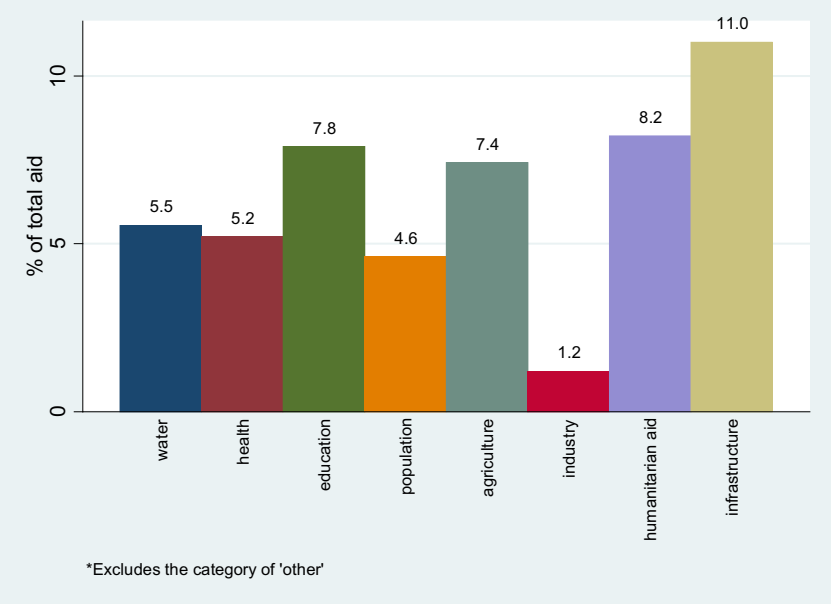

Figure 3. *Sectoral shares of foreign aid in total aid in SSA, 1990–2010.*

Table 4. *Impact of aid to water and sanitation sector on access to sanitation*

	Rural		Urban	
	Fixed effects	GMM (two-step estimates)	Fixed effects	GMM (two-step estimates)
Aid to water and sanitation (% of GDP)	0.504*	0.169***	−0.218	−0.074**
	(0.097)	(0.000)	(0.426)	(0.022)
Square of aid to water and sanitation (% of GDP)	−0.051*	−0.017***	0.013	0.003
	(0.061)	(0.000)	(0.610)	(0.288)
Percentage of rural population with access to water	0.193***	0.029	0.023	0.010
	(0.000)	(0.132)	(0.348)	(0.147)
Log of GDP per capita	4.113***	0.471	3.302***	−0.317
	(0.000)	(0.241)	(0.000)	(0.140)
Age dependency ratio	−0.220***	−0.023	−0.044	−0.021
	(0.000)	(0.312)	(0.192)	(0.684)
Female literacy rate	−0.042	−0.002	0.179***	−0.006
	(0.206)	(0.835)	(0.000)	(0.905)
Government spending on health (% of GDP)	0.398***	0.015	0.267***	−0.081*
	(0.001)	(0.359)	(0.009)	(0.089)
Government stability	0.186	0.170	−0.939	−0.137
	(0.824)	(0.236)	(0.215)	(0.362)
Post-2000 dummy	0.277	0.062**	−0.916***	−0.005
	(0.399)	(0.036)	(0.002)	(0.894)
Percentage of rural/urban population with access to sanitation in previous year		0.642		0.987***
		(0.781)		(0.000)
Constant	11.847*	0.169***	22.284***	4.474
	(0.074)	(0.000)	(0.000)	(0.364)
Within *R*-squared	0.568		0.334	
Between *R*-squared	0.105		0.291	
Overall *R*-squared	0.093		0.2608	
Sargan test: Chi2 ($p >$ Chi2)		21.413 (1.000)		19.167 (1.000)
AR(2) test: z ($p > z$)		0.763 (0.445)		0.605 (0.545)
Observations	367	338	367	338
Number of countries	29	28	29	28

The dependent variable is the percentage of the population with access to sanitation (rural and urban, respectively). Robust *p*-values are given in parentheses. The asterisks indicate significance at 1% (***), 5% (**), and 10% (*).

Table 5. *Impact of aid to water and sanitation sector on access to water*

	Rural		Urban	
	Fixed effects	GMM (two-step estimates)	Fixed effects	GMM (two-step estimates)
Aid to water and sanitation (% of GDP)	−0.561	0.312***	−0.682	0.030**
	(0.363)	(0.001)	(0.197)	(0.014)
Square of aid to water and sanitation (% of GDP)	0.029	−0.019***	0.037	−0.003
	(0.607)	(0.008)	(0.440)	(0.197)
Log of GDP per capita	10.945***	0.684	0.813	0.357**
	(0.000)	(0.307)	(0.577)	(0.014)
Age dependency ratio	0.180**	0.052	0.018	−0.030**
	(0.017)	(0.269)	(0.784)	(0.039)
Female literacy rate	0.475***	0.051	0.479***	−0.009
	(0.000)	(0.129)	(0.000)	(0.402)
Government spending on health (% of GDP)	0.030	0.120***	−0.421**	−0.005
	(0.896)	(0.008)	(0.034)	(0.915)
Government stability	−4.675***	−0.070	2.116	0.127
	(0.006)	(0.605)	(0.143)	(0.178)
Post-2000 dummy	3.737***	0.214***	0.543	−0.131***
	(0.000)	(0.005)	(0.320)	(0.000)
Percentage of rural/urban population with access to water in previous year		0.932***		0.981***
		(0.000)		(0.000)
Constant	−52.916***	−7.638	54.643***	3.070
	(0.000)	(0.349)	(0.000)	(0.193)
Within *R*-squared	0.539		0.353	
Between *R*-squared	0.277		0.174	
Overall *R*-squared	0.277		0.224	
Sargan test: Chi2 ($p >$ Chi2)		19.319 (1.000)		14.795 (1.000)
AR(2) test: z ($p > z$)		0.81 (0.418)		0.151 (0.88)
Observations	367	338	367	338
Number of countries	29	28	29	28

The dependent variable is the percentage of the population with access to water (rural and urban, respectively). Robust *p*-values are given in parentheses. The asterisks indicate significance at 1% (***), 5% (**), and 10% (*).

of growth and social development in SSA since the turn of the century. This also corresponds with the era of the MDGs. The models for access to sanitation include an extra variable—the share of the rural population with access to an improved water source. This is motivated by the fact that having access to an improved water source would facilitate the provision of improved sanitation facilities.

Determinants of access to services that are not adequately captured in our model may also affect the results. Problems likely to arise from omitted variable bias are addressed using the fixed-effects estimation method. Potential problems associated with endogeneity of regressors are addressed using the system generalized method of moments estimator (system GMM) (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). Using both estimation methods enables us to assess the robustness of the results to different estimation techniques.

(c) *Econometric results*

The econometric estimation results are presented in Tables 4–7. Tables 4 and 5 contain the results of the regression for the equations for rural and urban access to sanitation and water, respectively. Tables 6 and 7 present results for the gap between urban and rural access to sanitation and water, respectively.

In the case of rural access to improved sanitation, the estimation results that take into account omitted country-specific factors (Table 4 column 1) as well as the GMM results which take into account the potential endogeneity of regressors (Table 4 column 2) show that aid to the sector has a non-linear effect on the percentage of the rural population that has access to improved sanitation.[4] The relationship appears to exhibit an inverted U-shape. An increase in aid allocation to the water and sanitation sector leads to an increase in access to sanitation up to a threshold, beyond which further increases in aid are associated with declining access to sanitation. The results suggest that a one percent increase in aid to the sector (as a percentage of GDP) is associated with between 0.1 and 0.5 percentage increase in the share of the rural population that has access to improved sanitation. This relationship turns negative, however, when aid to the water and sanitation sector reaches around 5% of GDP. Note that the average ratio of aid to the water and sanitation to GDP for the sample is 0.5%, suggesting that few country-year observations exceed this threshold. These results are robust to the estimation methodology. Therefore, we may conclude that an increase in foreign aid will generally have a positive effect on access to sanitation in SSA.

Separate regression results for urban access to sanitation (Table 4, columns 3 and 4) yield mixed results: the fixed effects regression do not show a significant relationship between aid and urban access to sanitation, and the GMM regressions show counterintuitive results for aid (negative effects) and government spending on health. The negative coefficient of the post-2000 dummy could be due to a combination of rapid urbanization in the region and stagnating progress in increasing access to sanitation in cities.

Table 6. *Impact of aid to water and sanitation sector on the urban–rural gap in access to sanitation*

	Fixed effects	GMM (two-step estimates)
Aid to water and sanitation (% of GDP)	−0.449*	−0.058*
	(0.070)	(0.081)
Square of Aid to water and sanitation (% of GDP)	0.044*	0.000
	(0.052)	(0.989)
Percentage of rural population with access to water	−0.071***	−0.031***
	(0.002)	(0.000)
Log of GDP per capita	−0.207	−0.293**
	(0.774)	(0.026)
Age dependency ratio	0.011	−0.063***
	(0.711)	(0.000)
Female literacy rate	−0.008	−0.026***
	(0.780)	(0.000)
Government spending on health (% of GDP)	0.003	−0.011**
	(0.976)	(0.018)
Government stability	0.119	−0.851***
	(0.862)	(0.000)
Post-2000 dummy	−0.616**	−0.230***
	(0.022)	(0.000)
Lagged value of urban–rural ratio		0.677***
		(0.000)
Constant	8.299	11.983***
	(0.125)	(0.000)
Within *R*-squared	0.181	
Between *R*-squared	0.091	
Overall *R*-squared	0.106	
Sargan test: Chi2 ($p >$ Chi2)		21.782 (1.000)
AR(2) test: z ($p > z$)		1.377 (0.169)
Observations	367	338
Number of countries	29	28

The dependent variable is the ratio of the percentage of the urban population with access to sanitation to the percentage of the rural population with access to sanitation. Robust *p*-values are given in parentheses. The asterisks indicate significance at 1% (***), 5% (**), and 10% (*).

Table 7. *Impact of aid to water and sanitation sector on the urban–rural gap in access to water*

	Fixed effects	GMM (two-step estimates)
Aid to water and sanitation (% of GDP)	−0.053	−0.007***
	(0.314)	(0.009)
Square of aid to water and sanitation (% of GDP)	0.006	0.001***
	(0.204)	(0.003)
Log of GDP per capita	−0.520***	−0.082***
	(0.000)	(0.000)
Age dependency ratio	−0.007	−0.002***
	(0.279)	(0.000)
Female literacy rate	0.007	0.000
	(0.202)	(0.492)
Government spending on health (% of GDP)	−0.012	−0.003***
	(0.553)	(0.000)
Government stability	0.280**	0.007
	(0.049)	(0.199)
Post-2000 dummy	−0.299***	−0.012***
	(0.000)	(0.000)
Lagged value of the urban–rural ratio		0.834***
		(0.000)
Constant	5.328***	0.945***
	(0.000)	(0.000)
Within *R*-squared	0.193	
Between *R*-squared	0.126	
Overall *R*-squared	0.109	
Sargan test: Chi2 ($p >$ Chi2)		20.888 (1.000)
AR(2) test: z ($p > z$)		−0.969 (0.333)
Observations	367	338
Number of countries	29	28

The dependent variable is the ratio of the percentage of the urban population with access to water to the percentage of the rural population with access to water. Robust *p*-values are given in parentheses. The asterisks indicate significance at 1% (***), 5% (**), and 10% (*).

In the case of rural access to water (Table 5), the GMM results (columns 2 and 4) suggest that the amount of aid allocated to the water and sanitation sector has a positive effect on access to an improved source of drinking water in both rural and urban areas. The positive impact of foreign aid on access to water is quantitatively similar to the effect of foreign aid on access to sanitation. The impact of aid on rural access to water is non-linear: rural access to water begins to decline as aid rises past 8% of GDP, which is very high in this sample of countries. This threshold effect is not significant for urban access to water. The impact of aid on rural and urban access to an improved water source is not statistically significant in the regressions that account for omitted country-specific factors (FE results, columns 1 and 3), reflecting wide cross-country variations in the amount of aid, access to water and the linkages between aid and access to water. [5]

The results generally suggest that an increase in official development aid that is explicitly allocated to water and sanitation is likely to have a positive impact on access to improved sanitation. In the case of the rural sector, the initial positive impact is followed by a negative impact as aid increases beyond a certain point. However, in the case of access to water in both the rural and urban areas, the effects may vary across countries based on country-specific circumstances. This justifies our inclusion of country-specific determinants of access to water and sanitation in the regression analysis as control variables.

The results on the control variables vary depending on the estimation method. An increase in access to an improved water source is positively associated with an increase in the share of population that has access to improved sanitation facilities in the rural sector; no effect in urban sector. Likewise, income per capita and government expenditure on health are positively related to access to water and sanitation. The results reflect the impact of a higher capacity to spend on water and sanitation for any given level of foreign aid to these sectors. A higher female literacy rate positively affects access to water, but appears to have no impact on access to sanitation: the coefficient on sanitation is only significant in the case of the rural sector. The post-2000 decade is associated with improvements in access to both water and sanitation for the rural sector. The estimated effects of the age dependency ratio and government stability are generally consistent with our expectations only in some specifications.

The results from the second set of estimations analyzing the relationship between aid and urban–rural disparities in access to sanitation provide further confirmation of a positive impact of foreign aid on rural access to sanitation (Table 6). The fixed effects estimation results (column 1) point to the existence of a negative relationship between aid disbursements and the urban–rural access gap so long as aid to the water and sanitation sector is below 5.1% of GDP (suggesting improvements in rural access to sanitation relative to urban access), while the GMM estimation suggests that an increase in foreign aid monotonically reduces the urban–rural access gap as illustrated by the negative coefficient on the aid to GDP ratio and the insignificant coefficient on the squared ratio (column 2). The fact that aid helps to lower the urban–rural gap suggests that aid may have a stronger impact on rural access to sanitation than on urban access to sanitation. [6]

Levels of aid to the water and sanitation sector below 3.5% of GDP appear to lower urban–rural disparities in access to water, suggesting that aid has a strong impact on rural access to water than on urban access to water. However, this effect is significant only in the GMM estimations, again suggesting substantial cross-country variations in the amount of aid, access to water and linkages between aid and access to water (Table 7, column 2).

The post-2000 decade is associated with a reduction in urban–rural disparities in access to water and sanitation. These results are consistent across the fixed-effects and GMM specifications. An increase in female literacy helps to reduce urban–rural disparities in access to sanitation as might be expected, although the coefficient on this variable is significant only in the GMM regressions. The GMM regressions also suggest that greater public expenditure on health is associated with a reduction in rural–urban disparities in access to both water and sanitation (Table 6, column 2; Table 7, column 2).

These results generally suggest that an increase in official development aid that is explicitly allocated to water and sanitation is likely to reduce urban–rural disparities in access to sanitation, although this effect may diminish at high levels of aid. However, in the case of urban–rural disparities in access to water, the results suggest that the effects vary across countries.

The quadratic shape of the relationship between aid to the water and sanitation sector and access to water and sanitation most likely illustrates cross-country heterogeneity (a cross-sectional phenomenon) rather than a temporal (within-country) phenomenon. In other words, the non-linearity is not driven by declining access in individual countries over time as the aid/GDP ratio increases, but by countries with large aid/GDP ratios that have low access to water and sanitation, perhaps as a result of inefficiencies in aid utilization. This interpretation is consistent with the observed significant cross-country heterogeneity exhibited by the regression results in the fixed-effects model.

Coverage of water and sanitation services in these countries may be lower due to a variety of structural constraints on the supply and demand for water and sanitation that do not entirely disappear with greater amounts of aid. For example, low household incomes can constrain the demand for these services, which will lead to poor coverage if cost recovery is important to the providers of water and sanitation services. Moreover, large-scale water projects may not be feasible in the absence of electricity to operate pumps. Geographical factors may be another example of an unobserved country-specific effect that alters the relationship between aid and access to water and sanitation. The presence of large areas of low population density or physical barriers such as dense forests and mountains may negatively impact the extension of water and sanitation infrastructure to the rural sector. Another reason for the quadratic relationship is that aid to the water and sanitation sector includes not only support for expanding access, but also support for behavior modification projects aimed at influencing the attitudes and practices of the population regarding water, sanitation and hygiene. While this kind of aid meets an important need, it does not by itself contribute to expanding access to water and sanitation services. However, by alleviating the fiscal constraints of the government, it may help to free up resources that can then be used to expand access to water and sanitation. Of course, whether or not this actually happens will vary from country to country depending on domestic political and cultural factors as well as public commitment to expanding access to social services. This may also help to explain the heterogeneity of the results across countries.

4. CONCLUSION

With the end of the MDGs period in 2015, there have been renewed calls for more ambitious development targets in the context of the Sustainable Development Goals, including universal access to improved water and sanitation. This study has produced new evidence on the impact of foreign aid on access to social services in sub-Saharan Africa. In particular, it sought to link access to water and sanitation in rural areas with disbursements of foreign aid targeting these services. The empirical results are consistent with the evidence from earlier studies that show that official development aid is important in improving social development outcomes. The evidence shows that increases in the allocation of foreign aid to water and sanitation infrastructure are associated with increased access to clean drinking water and improved sanitation facilities in the rural areas in sub-Saharan African countries. This implies that targeted aid can be an important tool for accelerating human development. The policy message is that in addition to scaling up aid disbursements to sub-Saharan African countries, donors also need to explicitly increase aid allocation to water and sanitation as well as other areas where the region exhibits the most substantial gaps vis-à-vis its development goals and relative to other regions. There is also a need to identify other structural constraints to the demand and supply of water and sanitation that may limit access, and consider how to allocate and utilize foreign aid to alleviate these constraints.

The findings in this study also have important implications for the role of official development aid in reducing gender inequalities as well as rural–urban disparities in social and human development. To the extent that foreign aid helps to alleviate constraints to access to water and sanitation, it can help to reduce the time spent by women and girls in fetching water (see Elson, 2002). It can also help reduce the incidence of water-borne illnesses, which would reduce both the disease burden on women and the time spent by women in caring for sick family members. This would free up women's time to be used for other productive activities, while also reducing gender gaps in education outcomes, with substantial positive effects on economy-wide productivity (see World Bank, 2011).

Improved access to water and sanitation in the rural area has substantial spillover effects on productivity and the overall wellbeing of the population. Of course, expanded supply of water and sanitation alone does not ensure that these services will be used by all who need them, or in the case of sanitation,

in the way that they are intended to be used. Uptake of water and sanitation services by the population is impacted by a variety of social, cultural, economic, and demographic factors. However, once the services are made available, these constraints can be overcome by devoting resources to promote the utilization of these services by the population. Thus, increasing the amount of foreign aid going to support water and sanitation projects in sub-Saharan Africa can substantially help accelerate progress toward achieving not only the SDGs on access to water and sanitation, but also the SDGs on gender equality and health as well as other Sustainable Development Goals.

NOTES

1. Bain *et al.* (2015) note that the negative coefficient on access to water in Wolf's study may be explained by the fact that donors may allocate less aid to the water sector in any given country if there is greater need in other sectors; e.g., in situations where water coverage is better than say educational attainment or health service coverage.

2. The authors are grateful to an anonymous reviewer for suggesting this interpretation.

3. We also specified a linear version of the model. The regression results for the linear model are not presented here in the paper, but we refer to them as appropriate. These results are available on request from the authors.

4. The regression results from a linear specification showed no relationship between aid and rural access to sanitation.

5. The results from regressions with a linear specification show that aid has a positive impact only on urban access to water; it has no significant effect on rural access to water.

6. Regressions with a linear specification show that aid has no significant effect on the rural–urban gap in access to sanitation.

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APPENDIX A.

Table 8. *Variables, definition, and data sources*

Variable and definition	Source
Total disbursement of aid to water and sanitation sector (constant USD); entered in the regression as percentage of GDP	OECD DAC, WDI and authors' calculations
Real GDP per capita (constant USD)	World Bank, World Development Indicators
Public health expenditure as percentage of GDP	World Bank, World Development Indicators
Age dependency ratio (the ratio of dependents—people younger than 15 or older than 64—to the working-age population—those ages 15–64)	World Bank, World Development Indicators
Percentage of rural population with access to improved sanitation facilities	World Bank, World Development Indicators
Percentage of rural population with access to improved water source	World Bank, World Development Indicators
Adult female literacy rate (percentage of women aged 15 and above who are literate)	World Bank, World Development Indicators
Government stability index	International Country Risk Guide (ICRG)
Post_2000 dummy (a dummy variable = 1 if year is between 2000 and 2010)	Authors' construction