Public Disclosure Authorized

Public Disclosure Authorized

Policy Research Working Paper 10430

The People's Voice and Access to Sanitation

John Nana Francois
Kwabena Gyimah-Brempong
Johnson Kakeu
Cristelle Kouame

WORLD BANK GROUP
Macroeconomics, Trade and Investment Global Practice
May 2023

Policy Research Working Paper 10430

Abstract

This paper estimates the effect of voice and accountability, which captures transparent electoral processes, free media, and freedom of expression, on access to sanitation services in developing countries. The core argument is that voice and accountability increases the visibility of sanitation as a public good and raises awareness of its benefits; hence, increasing its supply and demand. The analysis utilizes data from 73 developing countries and an instrumental variable approach to identify the causal effect of voice and accountability on access to, and use of, sanitation. The paper also employs a novel *instrument-free estimator* as both an alternative estimator for the analysis and an empirical strategy to formally assess the validity of the instrument in a just-identified model—a previously untestable just-identifying exclusion restriction. The paper finds robust evidence that voice and accountability increase access to sanitation and help close the persistent rural-*urban inequality* in access to sanitation. The results suggest that key tenets of democracy such a freedom of speech, free media, and power of electoral incentives are not a luxury of the rich—they are relevant to the world's poor as they can shape the demand and distribution of sanitation services.

This paper is a product of the Macroeconomics, Trade and Investment Global Practice. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at jfrancois1@worldbank.org_and ckouame 1@worldbank.org.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

Produced by the Research Support Team

The People's Voice and Access to Sanitation*

John Nana Francois†
World Bank

Kwabena Gyimah-Brempong‡
University of South Florida and IZA

Johnson Kakeu§
University of Prince Edward Island

Cristelle Kouame¶
World Bank

JEL Classification: C26, D72, H41, H42, O18, P16
Keywords: Sanitation; Voice and accountability; Awareness and visibility; Rural and urban; Instrumental variable; Instrument-free estimator

*We are grateful to Michael Bleaney, Robert Johann Utz, Chiara Bronchi, Yaw Nyarko, Zalda Feliciano, Maty Konte, Leonce Ndikumana, Mina Baliamoune-Lutz, Jesse Mora, Grace Phillips, Eric Hoffmann, Anne C. Barthel, Kodama Toyoko, Berta Macheve, and Guy Tchuente for useful comments, feedback, and discussions on earlier versions of the paper that have significantly improved the paper. We would also like thank conference participants and discussants at the 2021 American Economic Association (AEA), the 2022 97th Western Economic Association International meeting in Portland, Oregon, and University of Prince Edward Island for useful discussions and feedback. We are solely responsible for any remaining errors.

Disclaimer: The findings, interpretations and conclusions expressed in this paper are entirely those of the authors and should not be attributed to the World Bank, its Executive Directors, or the countries they represent.

†Fiscal Policy and Sustainable Growth Unit, World Bank, 701 18th Street NW, Washington, DC20433, US.

‡Department of Economics, University of South Florida, Tampa, FL 33620, Tel: (703) 798-2438 email: kgyimah@usf.edu and IZA-Institute of Labor Economics, Bonn.

§Email: jkakeu@upei.ca. Department of Economics, 550 University Avenue Charlottetown, Prince Edward Island Canada C1A 4P3

¶Email: ckouame1@worldbank.org. World Bank, 701 18th Street NW, Washington, DC20433, US (J10-042)

1. Introduction

> "I stuck my neck out today when I said we have to break taboos because people didn't even mention the word toilet in the UN [United Nations] five years ago ... We need to break taboos ... We don't speak about [defecation], there's a shame factor which is horrible. It is the most natural of human needs, which causes enormous problems which relate both to health and dignity."— Jan Eliasson UN Deputy Secretary-General on his speech at the World Water Week in Stockholm on September 2, 2013 to the Guardian.

This paper studies the causal effect of voice and accountability (*Voice*, henceforth), which broadly captures transparent electoral processes and free media and accountability, on the access to sanitation in developing countries.[1] The paper also investigates the effect of *Voice* on rural/urban gaps in access to sanitation. We do so by: (1) estimating the effect of *Voice* on the percentage of people using basic sanitation for 73 developing countries; (2) examining whether *Voice* increases access to sanitation in rural and urban areas; and (3) investigating whether *Voice* closes the persistent rural-urban gap in access to sanitation in developing countries. Our core argument is that *Voice* increases sanitation's visibility as a public good, raises awareness of its benefits to households who demand its production, and pushes governments to respond to pressure to increase the supply of sanitation.[2] We instrument for *Voice* using the average years of schooling in 1900. We find that *Voice* has a positive, statistically and economically significant effect on access to sanitation services. This positive effect generally holds true in urban and rural areas. The results are also robust to different model specifications and estimation methods. Furthermore, the results show that *Voice* can be used as an effective vehicle to close the persistent rural-urban inequality in access to sanitation.

Access to sanitation, measured as the percentage of people using at least basic sanitation services—improved sanitation facilities that are not shared with other households—is fundamental to improved human health. This measure encompasses both people using basic sanitation services as well as those using safely managed sanitation services.[3] Recent updates of Sustainable Development Goal 6 (SDG 6) show that the developing world has seen significant progress in the number of people with access to sanitation.[4] However, globally, 3.6 billion people still live without access to basic sanitation, and approximately 8 percent of the world's population still practice open defecation (United Nations, 2021). Furthermore, it is well-documented that the sanitation crisis is most acute in rural areas, home to 91 percent of the people who defecate in the open and 72 percent of those without basic sanitation. Additionally, the lack of access to sanitation poses a serious threat to vulnerable populations as it exposes them to serious environmental health risks (Alzúa, Djebbari, and Pickering, 2020). In fact, poor sanitation is a leading risk factor for infectious diseases, including cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio. There is also strong evidence that lack of access to sanitation exacerbates malnutrition, and in particular, childhood stunting (WHO , 2019).[5] Access to sanitation also improves education outcomes. For example, Adukia (2017) finds that latrine construction increases female school enrollment in India, particularly those who may be vulnerable to illnesses caused by uncontained waste. Similarly, Spears and Lamba (2016) find that early exposure to a sanitation campaign through India's Total Sanitation

[1] Throughout the paper, we often use voice and accountability to also capture free media and transparent elections.

[2] This argument is in line with Kaufmann et al. (2019), who find evidence that suggests that "voice"-related variables such as citizen voice and transparency has a larger effect on the public sector service delivery performance and corruption. More practically, recent sanitation policy iterations have targeted demand for sanitation through media campaigns, capacity building, and community activities (Pakhtigian et al., 2022). The focus has shifted to education and communication, coupled with a continued emphasis on direct infrastructure provision and subsidization.

[3] We follow the World Health Organization's (WHO) definition of sanitation as access to facilities for the safe disposal of human waste as well as having the ability to maintain hygienic conditions. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, compositing toilets or pit latrines with slabs.

[4] See details on SDG 6 here: https://www.un.org/sustainabledevelopment/water-and-sanitation/ at United Nations.

[5] https://www.who.int/news-room/fact-sheets/detail/sanitation

Campaign improves childhood cognitive skills. The direct role of sanitation on educational outcomes suggests that lack of access to sanitation is a threat to human capital formation, which is an important driver of long-term growth and development. Despite its benefits, governments in developing countries have not provided sufficient investment, administrative support, and continuous oversight for the substantial provision of basic sanitation services.

Table 1 provides a first look at the progress made in access to electricity and water compared to sanitation services in low-income countries. Over the 2010 to 2019 period, access to electricity and water services increased by 14.07 and 7.97 percentage points, respectively. Meanwhile, access to sanitation services increased by only 0.68 percentage points in low-income countries. This marginal increase in access to sanitation may be partly driven by the fact that there is less public awareness of, and perhaps, lower priority given to, the sanitation problem— i.e., sanitation is a "low visibility good" in developing countries— compared to electricity or water services.

Table 1: The change in access to basic public goods in low-income countries, 2010-2019

Public good/service	2010	2019	Change (% Points)
Electricity (% of population)	26.85	40.92	14.07
Water services (% of population)	49.85	57.80	7.95
Sanitation services (% of population)	44.56	45.24	0.68

Source: Authors' calculation of World Bank's World Development Indicators. Access to electricity is the percentage of population with access to electricity. Water services (% of population) is the percentage of people using at least basic water services. This indicator encompasses both people using basic water services as well as those using safely managed water services. Basic drinking water services is defined as drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip. Improved water sources include piped water, boreholes or tubewells, protected dug wells, protected springs, and packaged or delivered water.

Access to sanitation is both a demand and supply problem. Specifically, households demand to use sanitation services, and governments have a key leadership and facilitating role (e.g., partnering with the private sector) in providing sanitation services. Households may be able and willing to pay for improved sanitation services, but the government's supply of public infrastructure is required to facilitate the final provision of these services. Without government provision of sanitation infrastructure, household demand for, and use of, sanitation may not be possible. In several rural areas in low-income countries, households may not be able to afford sanitation services— i.e., demand is nonexistent simply because income is too low. In such a case, the government can provide sanitation services (e.g., public toilets) as public goods to serve the poor at little to no cost.[6] On the other hand, if the supply of sanitation service is available, people will have the incentive to access and use these necessities. For several people in the developing world, however, the immediate and long-term benefits of accessing and using quality sanitation services and the facilitating role of government in providing these services are not well-communicated. Hence, the demand, and consequently, the supply for basic sanitation services might be low partly because of low awareness from lack of information. Moreover, even if there is awareness of the sanitation problem, the suppression of discussions and media campaigns around it can keep the problem hidden and hence, make it less visible as a priority policy issue. These may be attributed to weak institutions related to voice and accountability.

Using average years of schooling in 1900 as an instrumental variable to identify the exogenous component of voice and accountability, we estimate the latter's impact on access to sanitation in 73 developing countries over the period 2002-2020. Our empirical analysis uncover the following results: First, we find that higher levels of *Voice*

[6] In situations where building sanitation infrastructure can generate positive externalities on the demand side, the empirical study by Gautam (2023) shows that a price subsidy is more effective than a targeted cash transfer in increasing the average sanitation adoption rate.

increases access to and use of sanitation. Specifically, after accounting for key covariates, our point estimate indicates that a 1 unit increase in *Voice* causes an 18 percentage points increase in access to and use of basic sanitation service. Second, we find that a unit increase in *Voice* leads to 12 and 32 percentage point increase in sanitation access in urban and rural areas, respectively. Third, the results reveal that increases in *Voice* decreases the rural/urban gap in access to sanitation. These results are robust across different estimators, specifications, and samples.

The causal impact of *Voice* on access to sanitation in developing countries suggests that *Voice* makes the sanitation problem visible. Once the problem is made visible, solutions may be seriously considered; hence, help increase the provision and access of sanitation services. Moreover, our findings imply that policies targeting the strengthening of institutions along the dimension of voice and accountability in developing countries will not only improve the latter but also induce an increase of access to sanitation. More precisely, policies that target the improvement of *Voice* can generate positive second order effects with important development implications. Furthermore, the results strongly suggest that *Voice* can be used as an effective vehicle to close the rural-urban gap in access to sanitation.

Our study makes four key contributions to the literature: First, we establish *causality* between *Voice* and access to, and use of, sanitation— previous studies have not established a casual impact of *Voice* on access to sanitation. Relatedly, our work focuses exclusively on the effect of voice and accountability on access to, and use of, sanitation in developing countries as opposed to simply using it as another control variable in previous studies. Second, we use a simple conceptual framework to shed light on the mechanisms—i.e., the demand and supply channels— through which voice and accountability might affect access to sanitation in developing countries. Third, our analysis identifies a rural-urban gap in access to sanitation and investigates the degree to which voice and accountability can close this gap. The result establishes that *Voice* can serve as an important vehicle in solving this critical and structural spatial inequality in access to sanitation. This can in turn improve well-known rural-urban gap inequalities in education and health. Fourth, the study applies a novel instrument-free estimator in kinky least squares (KLS) to formally test the validity of our instrumental variable— a previously untestable just-identifying exclusion restriction. Importantly, as a robustness exercise, we employ the KLS as an alternative estimator to establish a causal effect of voice and accountability on access to and use of sanitation.

The rest of the paper is organized as follows: Section 2 briefly summarizes the related literature on the subject, Section 3 introduces a simple conceptual framework to shed light on how voice and accountability can impact access to sanitation. Section 4 describes the data and discusses the methodology. Section 5 presents and discusses the estimation results. Section 6 concludes.

2. Related literature

Despite its importance, the development economics literature has paid scant attention to sanitation (Ravilla et al., 2021). However, this is rapidly changing as the literature has begun to pay serious attention to the subject in light of the prominence given to it in the SDGs. Recent studies of sanitation in the development economics literature have focused on three main areas: the impact of sanitation on development outcomes; the supply of, access to, and use of sanitation services; and the role of external aid in the provision of sanitation. Our paper focuses on the effects of voice and accountability on access to and use of sanitation; hence, we do not focus on the literature that investigates the effect of sanitation on development outcomes. We therefore limit our literature review to the supply and demand for sanitation, and the role of foreign aid in the supply, access and use of sanitation.

On the demand side, several studies have stressed the importance of income (Immurana et al., 2022); education and information (Alexander et al., 2019), Adil et al. (2021); Legge et al. (2021); Pakhtigian et al. (2022), resource constraints, as well as socio-cultural environment (Munamati et al., 2016) as important determinants of the access to, and use of, sanitation infrastructure and services. The argument is that information and education shift household preferences towards sanitation use while increasing income and relaxing resource constraints, generally, make sanitation services affordable to households. These studies have been conducted mostly at the aggregate level and do not establish causality. Other researchers stress the importance of accountability and advocacy as important factors in access and use of sanitation services. Some studies also highlight the critical role of information and peer effects in overcoming social and cultural barriers in the use of sanitation (Adil et al., 2021; Alexander et al., 2019; Legge et al., 2021; Pakhtigian et al., 2022, among others)

Researchers interested in the supply of infrastructure services have focused on the characteristics of sanitation infrastructure and services, political institutions and the environment in which services are provided as well as political accountability and advocacy generated through voice and accountability. Ashraf et al. (2016) and Batley and Mcloughlin (2015) argue that sanitation infrastructure and services are characterized by indivisibility as well as externalities; hence, have to be provided by the public sector else the quantity provided will be sub-optimal. In low income countries, private provision may not even be feasible because of affordability. Other researchers have focused on the type of political institutions that provide sanitation services more effectively. Deacon (2009) argue that democracies provide better public services, including sanitation, to citizens relative to autocracies, probably because of increased accountability. Similarly, Keefer and Khemani (2005); Khemani (2015) argue that political incentives emanating from visibility and political pressure determines which public goods will be provided in a society.[7] Looking at sanitation issues through an institutional lens, data from 85 countries are analyzed by Anbarci et al. (2009) to show that corruption negatively affects both efforts to improve drinking water and sanitation. Breen and Gillanders (2022) using data on 45,000 households' across Africa provide strong evidence that local corruption in the utilities sector impedes everyone's access to clean water and sanitation. Similarly, some researchers argue that the supply of sanitation is influenced by the institutional environment (Francois et al., 2021; Hepworth et al., 2022; Hout et al., 2022).

An aspect of the provision of public services generally, and sanitation in particular, is *visibility* and accountability. The more visible a project is and the more policy makers are held accountable for its provision, the greater the quantity of such services that will be provided; the reverse is also true—policy makers tend to provide less of services that are not visible and for which they are not held accountable. *Voice* shines a spotlight on sanitation thus making it *visible* as well as helping to keep policy makers *accountable* for its provision. Adil et al. (2021) finds that information and increased accountability improves access to safe drinking water and sanitation in Punjab, Pakistan. Similarly, Hout et al. (2022) finds that increased accountability increases both access and sustainability of sanitation in Kenya.

A large amount of research focuses on testing the effects of foreign aid in providing access to sanitation (Abellán and Alonso, 2022; Gopalan and Rajan, 2016; Ndikumana and Pickbourn, 2017; Pickbourn et al., 2022, among others) and generally finds a significant and positive effect of aid on access to sanitation. These studies are generally conducted at the aggregate level using a variety of estimation methods. These researchers argue that international aid affects the demand for sanitation by changing the marginal utility of sanitation through health education and other information

[7] An interesting case is provided by Narzetti and Marques (2021), who seem to suggest that in vulnerable areas in Brazil, sanitation issues have a very low degree of visibility in the eyes of regulators than they do elsewhere. One way to see it is that governmental entities resign from their roles there, as evidenced by the lack of inclusion and application of regulation and public policies in vulnerable areas.

channels. On the supply side, foreign aid works to reduce the marginal cost to household as well as decrease the cost of provision to governments tat otherwise may not be able to afford to provide the infrastructure.

With the exception of Abellán and Alonso (2022), previous research focuses exclusively either on the demand side or the supply side without integrating supply and demand for access to and use of sanitation. We do so in this paper. Second, although some papers have mentioned voice and accountability, they do not focus on it as the central issue in their analyses. Finally, none of these studies establishes the direction of causation between voice and accountability on the one hand and access and use of sanitation on the other. Our paper addresses these issues by investigating the *causal effects* of *Voice* on sanitation access and does so within a supply and demand framework. In addition, our study extends the analysis to study rural and urban areas alongside the role of voice and accountability in closing the rural/urban gap in access to sanitation. Besides using instrumental variables estimation to overcome possible endogeneity problems, we also use a novel instrument free estimator in kinky least squares developed by Kiviet (2013, 2022) as a robustness check on our results. Our primary approach in this study is the use of cross-section data and thus does not explicitly account for time dimension. The use of cross sectional data allows us to use our estimation methodology and draw causality in the process.

3. Conceptual framework: demand and supply channel of voice & accountability

Access to and use of sanitation services is a two-part problem— a demand side and a supply side issue. In this section, we provide a brief description of the channels through which *Voice* can directly broaden access to sanitation by stimulating the demand and supply.

On the demand side, households are the main beneficiaries of sanitation services and hence, have the key responsibility of gaining access to it. In low information environments, lack of awareness of the benefits of sanitation as well as government's inability or unwillingness to provide sanitation services can lower the demand for these services by households. The lack of information issue is likely to be more pervasive in rural areas compared to urban areas. Notice that when the freedom of the media is suppressed by government, certain socioeconomic issues may not be publicly discussed and certain educative information may not reach the populace. In contrast, a free media can effectively serve as a medium in communicating key information to citizens on the benefits of sanitation. Consequently, by providing the appropriate health information and education about the benefits of sanitation through TV and radio advertisements for example, *Voice* can stimulate the demand for sanitation, all things equal.

Formally, we can consider that households maximize a utility function that is positive and concave in sanitation services and a bundle of all other consumption goods and services (X) subject to budget constraints. Additionally, we assume that households gain utility from an exogenous level of *Voice* v in the country that is complementary to sanitation services. Specifically, voice increases the marginal utility of sanitation and hence, the demand for sanitation. Algebraically, the household utility is given as $U = u(s, X, v)$, $\partial U/\partial s > 0$ and $\partial U/\partial s \partial v > 0$. The last term captures the complementarity (in the Edgeworth pareto sense) between voice and sanitation services in utility, so that an improvement in voice and accountability raise the marginal utility of sanitation services and hence, its demand. We can summarize the demand function for sanitation service as $s^d = g(v, Z)$, where Z captures other factors that may affect the demand for sanitation and $\partial s^d/\partial v > 0$.[8]

[8] Other factors such as lack of basic income and credit constraints can reduce demand for the adoption of safely managed sanitation services. Indeed, credit constraints often limits poor households in the adoption of privately optimal technology (e.g., flushable toilets or energy efficient technologies) that can improve household lifestyle. See for instance, Berkouwer and Dean (2022) for the case of adoption of energy efficient

On the supply, there is a key role for governments in broadening access to sanitation. A primary responsibility of governments is to provide investment in sanitation infrastructure in order to increase sanitation delivery services to households.[9,10] Given scarce public resources, there may be incentives for government facing elections not to provide sanitation services, as they channel these resources to the more visible public goods such as roads, electricity, and water services that can win them elections relative to low visibility services such as sanitation. However, effective media can spark social action by highlighting the pervasive nature of lack of sanitation and the role of governments in facilitating sanitation services, thus increasing its visibility. Another argument, often discounted in the literature, is the inherent characteristic of sanitation. Sanitation is more of a merit good rather than a pure public good; hence, governments can remain agnostic on its role in the provision of sanitation services and shift responsibility to the private sector unless forced to do so through civic/political action.[11] An effective media and environment that allows for peaceful protests can help hold governments accountable by spelling out the government's role in the provision of sanitation services.

As discussed above, politicians are likely to supply more high visibility public goods/services for which they can take credit and be held publicly accountable by the electorate in order to boost their electoral chances. We assume that the politician's objective is to be (re) elected, which is an increasing function of the quantity and quality of public services (including) sanitation, provided i.e., $Pr(E) = f(s, \Omega), \quad \partial Pr(E)/\partial s > 0$, where $Pr(E)$ is the probability of the politician getting (re)elected, Ω is all other variables that affect the politician's re-election chances, all other variables as defined above. Sanitation services may not always fall in the priority list of "high-visibility" expenditure programs, such as electricity, famine relief, road construction, and water, geared to the groups of voters most beneficial to the incumbent government (Mani and Mukand, 2007) in low income, low information countries. Free media acting as information multipliers can, not only make sanitation services visible, but can also hold politicians accountable for lack thereof. We assume that because politicians want to increase their electoral chances, the push for the increase in sanitation services by the electorate through voice and accountability will induce government to supply more sanitation services, i.e. $s^s = \psi(v), \quad \partial s^s/\partial v > 0$,[12] [13] The role of the media and communicators as information multipliers is therefore paramount to public advocacy and awareness-raising, which can increase the visibility of sanitation and hence, access to sanitation.[14]

technologies in Kenya.

[9] Ashraf et al. (2016) illustrate the complementarity between infrastructure and institutions and shows how institutional weaknesses determine whether fines, subsidies, both or neither are optimal. With general strong institutions, the latter (i.e., fines and/or subsidies) is one of the ways government can play a leading role in sanitation delivery services.

[10] A practical example of government's role in leadership and administrative support and oversight in the provision of sanitation delivery service is the Greater Accra Metropolitan Area Sanitation and Water Project (GAMA) project in Ghana. GAMA is being implemented by the Ghana Water Company and the Ministry of Sanitation and Water Resources with funding support from the World Bank.

[11] Merit goods could be, and indeed are, provided through the market, but not necessarily in sufficient quantities to maximize social welfare.

[12] Conceptually, $\partial s/\partial v \neq 0$ since the politician will choose not to respond to the news or might conclude that the available sanitation service is enough. We rule out these possibilities because we assume that the politician wants to maximize electoral probability and that the level of sanitation service is very low in our setting.

[13] We also provide a simple stylized model to further explain how voice and accountability may impact access to and use of sanitation. We embed the concept of visibility of a public good into a tractable political economy framework to model the delivery of sanitation services in a country with the key tenets of voice and accountability—i.e., free media, transparent elections, and freedom of speech as inputs. See Appendix A for details. See, https://www.un.org/waterforlifedecade/waterandsustainabledevelopment2015/stakeholders_media.shtml for additional details on the role of the media in raising awareness to the sanitation problem

[14] Another argument discussed in the corruption literature is that governments tend to invest less in small projects where they cannot gain a lot of rent. In general corrupt governments would prefer to invest more in big infrastructure such as roads where they can get a big share of the money. However, education or perhaps sanitation projects are not attractive enough for government officials to gain maximum rent (see for example Mauro, 1998). Here, voice and accountability can serve as first line of imposing checks and balance to reduce corruption in how funds are used by the government and make sanitation services an important public good that needs attention from politicians by unearthing the

Combining the effects that *Voice* has on the demand for, and supply of sanitation, we see that equilibrium access to and use of sanitation services in developing countries positively depends on voice and accountability and other factors—$s^* = s(v, Z), \quad \partial s^*/\partial v > 0$, where s^* is the observed amount of sanitation services provided in a country. In this simple formulation, *Voice* can increase sanitation access through the demand side by households, the supply side by government, and/or other factors.

4. Data and Estimation Methods

This section describes the various layers of the country-level analyses of the influence of *Voice* on access to sanitation, discusses key variables employed, as well as the empirical strategies implemented to identify the causal effect of *Voice* on access to sanitation. Our analysis focuses on measures of access to sanitation, exploiting variations in cross-country data. We estimate the effect of *voice* on: (i) overall access to sanitation, (ii) access to sanitation in rural and urban areas, and (iii) closing the rural/urban gap in access to sanitation. The first sub-section describes the data while the second sub-section briefly describes our estimation methods and empirical strategy.

4.1 Data and descriptive statistics

In this section, we present descriptions and data sources for our main variables. We utilize data from 73 developing countries to study the effect of voice and accountability on access to sanitation. We measure our dependent variable, the access to sanitation (S) in four different ways: (1) the proportion of the entire population using basic sanitation (S_t), (2) proportion of rural population using basic sanitation (S_r), (3) proportion of urban population using basic sanitation services (S_u), and (4) the rural-urban gap in access to sanitation (S_g). The data for S and its various components is from *World Development Indicators (2021)*. Our main explanatory variable is the institutional variable, voice and accountability (*Voice*). This variable captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. We employ the standard measure of freedom of expression, of association and free media as our measure of *Voice*. The standard measure of this variable ranges from -2.5 to 2.5 with higher values being associated with better outcomes and hence, higher levels of quality *Voice*. We use this index because it provides the most up-to-date measure of broad institutions relevant to the time period we consider. The data on*Voice* comes from the *Worldwide Governance Indicators* constructed by Kaufmann, Kraay, and Mastruzzi (2011).

We include potentially important control variables in our empirical estimation. In particular, we include GDP per capita and population density. GDP per capita is included as a measure of income level as well as a proxy for overall economic development in each country. Per capita GDP is measure is real terms (constant 2015 US$). We expect a positive relationship between access to sanitation and the level of per capita income across countries. We include population density in the analysis to control for possible scale or scope economies effects. The relationship between population density and access to sanitation can be positive or negative. A positive relationship may arise because higher population density could mean lower administrative costs as well as scale economies and thus translate lower cost of access to improved sanitation facilities for a larger segment of the population (Gopalan and Rajan, 2016). On the other hand, sanitation is a rival good at least in low and lower-middle income countries, hence, higher population density could be associated with lower access to sanitation as a share of the population. Data on per capita GDP and population density were obtained from the World Development Indicators (World Bank, 2021). Controlling for these factors may help with minimizing specification errors.

severity of the sanitation problem.

Table 2: Summary Statistics

Variable	obs	Mean	SD	Min.	Max.
People using sanitation services, total (share of population)	73	0.63	0.28	0.11	0.99
People using sanitation services, urban (share of urban population)	72	0.71	0.25	0.21	0.99
People using sanitation services, rural (share of rural population)	72	0.54	0.29	0.05	0.97
Rural-Urban Gap	72	0.17	0.12	-0.03	0.49
Voice and accountability index (lowest = -2.5 highest =2.5)	73	-0.41	0.69	-1.79	1.04
Mean year of schooling, 1900	73	0.27	0.39	0.01	1.52
Log GDP per capita	72	7.84	0.97	5.85	9.44
Log population density	73	4.20	1.10	1.26	7.04

Notes: SD is the standard deviation of the variables. The mean difference (i.e., rural - urban gap) of 0.17 is statistically different from zero with *p*-value of 0.0002.
Source: Authors' illustration from the World Development Indicators World Bank (2021)

Table 2 presents the summary of the data. The data are for 73 developing countries over the 2002 to 2020 period. We also report the country-by-country data for the four measures of the dependent variable used in our cross-sectional analysis in Table 3. We observe from Table 2 that, on average, 63% of the population in our sample has basic sanitation services. The standard deviation, at 28% is, however, relatively large, indicating high variability in the proportion of the population using basic sanitation across countries. In particular, several Sub-Saharan African (SSA) countries in the sample, have less than 30% of their population using basic sanitation services. These countries include Sudan (29.1%), Côte d'Ivoire (27.8%), Zambia (27.7%), Malawi (24.1%), Mozambique (23.7%), the Democratic Republic of Congo (19.3%), Uganda (18.5%), Liberia (16.2%), Ghana (15.7%), Togo (14.2%), Sierra Leone (13.6%), Benin (13.2%), and Niger (10.7%) (see, Table 3). In contrast, there are countries in our sample with more than 90% basic sanitation services access and usage. Additionally, more than a third of countries in our sample have less than 50% of their population accessing and using sanitation services over the period. Finally, Table 2 reports the summary statistics for the standard control variables in our estimation—i.e., logarithm of GDP per capita and population density. The mean value of log GDP per capita is 7.84 with a standard deviation of 0.97 while that of lop population density is 4.20 with a standard error of 1.12. These suggest large variances in per capita income and population density across countries in our sample.

We now switch our attention to rural and urban access to sanitation. As shown in Table 2 the means of the percentage of people with access to sanitation in rural and urban areas are 54% and 71%, respectively, suggesting the existence of a rural-urban gap in access to sanitation. A simple t-test confirms that the rural-urban gap is statistically significant at conventional levels (mean difference = 0.17, $p-$value = 0.0002). The country-by-country summary in Table 3 provides a granular look and reinforces rural-urban inequality. With the exception of Sri Lanka, Thailand, and Jamaica, where the rural-urban gap is negative, the gap is positive in all other countries. Additionally, while the rural-urban gap is highest in Yemen Rep. (49.2%) and Cambodia (42.2%); the gap is generally high in Latin American and African countries— e.g., Argentina, Brazil, Cameroon, Côte D'Ivoire, Mozambique, Peru, Panama, Niger, Liberia, Guatemala, Zambia, and Tunisia, where it is above 20 percent. (See, Table 3).[15]

It is worth highlighting that while the rural-urban gap is small in countries such as Congo, Dem. Rep., Lesotho, and Kenya, these countries have low access to sanitation in both rural and urban areas. Hence, the low gap in access to sanitation is not indicative of a lack of sanitation problem in in these countries; it is in fact the result of a chronically low access to sanitation in both rural and urban areas. In contrast, countries like Malaysia, Jordan, Serbia, and Costa

[15]Romania has one of the highest rural-urban gap in access to sanitation outside Latin America and Africa

Table 3: Percentage of people using basic sanitation services

Country	Access to sanitation (%)			Gap	Country	Access to sanitation (%)			Gap
	% Pop.	% Rural Pop.	% Urban Pop.			% Pop.	% Rural Pop.	% Urban Pop.	
Malaysia	98.7	97.3	99.4	2.10	Philippines	70.5	65.9	76.0	10.1
Jordan	97.8	96.7	97.9	1.30	South Africa	69.9	63.0	74.5	11.4
Serbia	96.7	94.9	98.1	3.20	Myanmar	69.2	64.9	79.9	14.9
Costa Rica	96.1	92.9	97.5	4.70	Nicaragua	67.4	54.6	77.1	22.5
Thailand	95.8	96.3	94.9	-1.4	Guatemala	65.4	51.7	80.0	28.3
Albania	95.5	92.9	98.1	5.10	Indonesia	63.9	52.1	76.1	24.0
Egypt, Arab Rep.	94.6	92.4	97.5	5.10	Eswatini	57.2	57.0	58.1	1.00
Mauritius	93.8	93.0	95.0	1.90	Pakistan	51.4	39.6	73.4	33.8
Türkiye	93.7	83.9	98.0	14.1	Bolivia	50.3	29.0	61.0	31.9
Argentina	91.9	74.3	94.6	20.3	Yemen, Rep.	50.1	34.3	83.6	49.3
Libya	91.5	—	—	—	Senegal	48.1	34.7	65.4	30.7
Fiji	90.5	86.6	94.3	7.80	Gambia, The	46.5	41.0	49.7	8.70
Syrian Arab Republic	90.5	88.1	92.6	4.50	Nepal	46.2	44.5	55.1	10.6
Cuba	89.4	82.1	91.7	9.60	India	45.4	36.8	64.8	28.0
Tunisia	87.9	73.0	95.5	22.5	Cambodia	41.2	32.5	74.7	42.2
Russian Federation	87.1	66.3	94.5	28.2	Cameroon	41.0	23.3	57.2	33.9
Sri Lanka	86.8	87.1	85.6	-1.4	Bangladesh	40.5	37.5	48.0	10.5
Algeria	86.4	77.2	90.8	13.7	Zimbabwe	40.5	33.8	53.9	20.1
Bulgaria	85.9	83.7	86.8	3.10	Afghanistan	36.6	32.7	48.7	16.0
Belize	85.9	82.5	90.0	7.50	Lesotho	32.2	31.1	35.8	4.70
Mexico	85.8	72.0	89.9	17.9	Kenya	31.9	30.7	35.5	4.80
Iran, Islamic Rep.	85.6	73.2	90.9	17.7	Mali	31.2	22.8	45.9	23.1
Iraq	85.5	77.9	88.9	11.0	Sudan	29.3	18.3	51.2	32.9
Colombia	85.3	72.4	88.9	16.5	Haiti	28.3	19.2	37.9	18.7
Jamaica	84.9	86.7	83.5	-3.2	Côte d'Ivoire	27.8	13.6	43.4	29.8
Guyana	83.5	81.5	88.8	7.30	Zambia	27.7	17.4	43.6	26.3
El Salvador	83.2	72.8	88.5	15.6	Malawi	24.1	22.4	33.2	10.8
Paraguay	83.1	72.0	90.9	18.8	Mozambique	23.7	12.3	46.9	34.6
Dominican Republic	82.9	73.9	86.0	12.1	Congo, Dem. Rep.	19.3	16.9	22.5	5.60
Brazil	82.6	51.0	88.5	37.5	Uganda	18.5	16.0	28.4	12.4
Ecuador	81.6	72.9	86.9	13.9	Liberia	16.2	5.30	27.9	22.6
Romania	80.0	63.4	94.4	30.9	Ghana	15.7	10.1	21.0	10.9
Morocco	78.8	62.2	90.6	28.4	Togo	14.2	5.50	28.1	22.6
China	77.0	67.5	87.3	19.8	Sierra Leone	13.6	7.20	23.6	16.3
Honduras	74.8	67.3	81.9	14.6	Benin	13.2	5.30	23.4	18.1
Panama	74.2	55.7	83.9	28.2	Niger	10.7	5.40	37.9	32.5
Peru	72.1	46.4	80.1	33.7					

Notes: Access to sanitation is People using at least basic sanitation services (% of population). Gap is the difference between People using at least basic sanitation services, urban (% of urban population) and People using at least basic sanitation services, rural (% of rural population).
Source: Authors' illustration from the World Development Indicators World Bank (2021).

Rica have low rural-urban gaps because access to sanitation in both areas is high.

4.2 INSTRUMENTAL VARIABLE A difficulty in estimating the effect of *Voice* on access to and use of sanitation is the possible endogeneity of *Voice*. While *Voice* may have a positive effect on access to sanitation, sanitation could also improve human capital and economic and institutional development of which *Voice* is a part. It is also possible that both *Voice* and access to sanitation are being driven by an unobserved common factor. In addition to these factors, institutional variables, such as *Voice* are measured with substantial errors (Rodrik et al., 2004). All these factors could introduce endogeneity when *Voice* is used in a regression analysis, making it difficult to infer causal effects.

Given the possible endogeneity of our independent variable, OLS estimates are likely to be biased. To address this endogeneity issue, we use primary school enrollment rate in 1900 as an instrument to achieving identification. The core argument is that historical levels of education plays an important role in teaching civic education and highlighting the role of governments while raising awareness of basic individual rights in civil society (Glaeser et al., 2007). This means that countries with historically higher levels of education will likely have societies with active civic participation. Moreover, with citizens being aware of their rights, they are more likely to push governments, through voting, mobilization and demonstrations, to act to address socioeconomic issues. Such civic participation induced by education can be passed down to later generations. Consequently, historical levels of education can be a durable good that impacts today's *Voice* in those countries. Beyond this intuitive explanation, a long-standing theory in political science argues that education is a key determinant of the emergence and sustainability of democracy, because it promotes political participation at the individual level and fosters a collective sense of civic duty. Specifically, findings from studies such as Lutz, Cuaresma, and Abbasi-Shavazi (2010) confirms a strong positive relationship between past levels of education and democracy even after controlling for many other country characteristics. While current levels of *Voice* may be correlated with primary school school enrollment in 1900, it is unlikely that primary school enrolment in 1900 will be correlated with current levels of access and use of basic sanitation. This makes primary school enrolment in 1900 a potentially good instrument for *Voice*. In summary, we can exploit a measure of education from historical times as an instrument for today's level of *Voice* across countries while assuming that it only impacts current levels of access to sanitation through its correlation with *Voice*.

In addition to using instrumental variable estimation, we apply a novel instrument-free identification strategy in kinky least squares (KLS), a non-parametric estimator, developed by Kiviet (2020, 2022). The primary motivation for this additional empirical step is as follows: Our model is a just-identified model hence, we cannot test whether our proposed instrument does not violate the exclusion restriction. The KLS estimator, which is an instrument-free estimator, allows us to formally test the exclusion restriction to validate our instrumental variable estimations. Furthermore, the KLS serves as an alternative estimator to examine the effect of *Voice* on access to sanitation, which we can compare with the estimates from the instrumental variable estimation. We also apply the KLS estimator to panel data to exploit the relevance of time dimension in the causal effect in question. Consequently, the KLS is used for model validation and robustness exercises. We discuss the details of the KLS estimator in Section 5.4.

4.3 Empirical strategy

The main regression equation we estimate is:

$$S_i = \alpha + \beta_1 \text{Voice}_i + \mathbf{X}_i^{'} \beta_2 + \varepsilon_i, \tag{1}$$

where the subscript i refers to countries, S_i is access to sanitation in country i, *Voice* is voice and accountability, $\mathbf{X}$ is a vector of the two control variables in our models, ε is a stochastic error term, and α and β are coefficients to be estimated. We begin with a parsimonious specification of a bivariate regression of access to sanitation on voice and accountability. We then proceed to our baseline estimation that includes the standard covarates that may affect access to sanitation. We follow the convention in the sanitation literature in specifying the covariates. The analysis implements empirical strategies to mitigate issues of endogeneity. To address these endogeneity issues, we employ an instrumental variable estimator for the causal analysis. Our instrument for *Voice* in our cross-country analysis is primary school enrollment in 1900.

We present ordinary least squares (OLS) estimates to show the correlation between *Voice* access to sanitation. We present the bivariate estimation as well as our estimations where we include the standard control variables. The estimates from the OLS estimates will help contextualize the severity of the endogeneity issue, which the 2SLS estimator will address. After presenting the OLS estimates, we proceed to present and discuss the 2SLS estimates. In addition to the OLS and the IV estimates, we also use an instrument-free non-parametric estimator, Kinky Least

Square (KLS) estimator to estimate the model as an added robustness check. In all the regressions, we control for geographical differences by including regional dummies. Throughout the paper, the standard errors that we report are robust against arbitrary heteroskedasticity.

5. Results

5.1 Ordinary least square regressions Table 4 presents results from the OLS regressions showing the correlation between basic sanitation use and *Voice* in total, rural and urban populations. Before proceeding to discuss the results, a few features of the table needs highlighting: Odd numbered columns report the results from the bivariate specification whereas even number columns report results that include the control variables in the regression model.

We now discuss the results for column 1 and 2. While the estimated coefficients are positive, they are small and statistically insignificant (Column 1). Furthermore, once we control for the level of GDP per capita and log population density, the coefficient of *Voice* becomes even smaller, close to zero and remains statistically insignificant. The relationship between per capita income and basic sanitation use is positive and statistically significant at conventional levels in all the regressions. On the other hand, we find no significant relationship between access to sanitation and population density. These results generally hold for access to sanitation in urban and rural areas (Columns 3 – 6).

Table 4: Ordinary least squares (OLS) cross-country regressions (Dependent variable: Sanitation)

	Total		Urban		Rural	
	(1)	(2)	(3)	(4)	(5)	(6)
Voice and accountability	0.074	0.006	0.053	0.001	0.083	0.012
	(0.047)	(0.024)	(0.041)	(0.022)	(0.053)	(0.033)
log real GDP per capita		0.197***		0.152***		0.191***
		(0.025)		(0.023)		(0.031)
log population density		0.012		-0.007		0.031
		(0.015)		(0.015)		(0.022)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.677	0.858	0.716	0.857	0.578	0.751
Observations	73	72	72	71	72	71

Notes: *** indicates significance at the 1% and 5% level. Robust standard errors in parentheses. South Asia is the region excluded in the regional dummies.

The finding of no significant relationship between access to sanitation and *Voice* is not surprising for the following reasons: The OLS regression is likely to be plagued with endogeneity problems. Consequently, the OLS estimates can not be relied on for causal inference. We therefore employ instrumental variable estimation to address the possible endogeneity problem and draw casual inference on the relationship between *Voice* and sanitation access and use.

5.2 Instrumental Variables estimation Table 5 presents the results from the two-stage least squares (2SLS) model. Odd (even) numbered columns present results for estimations where we exclude (include) the standard control variables. Panel A of the table reports the 2SLS estimates of the effect of *Voice* on access to sanitation services.

Table 5: The effect of voice and accountability on access to sanitation

	Full Population		Urban Population		Rural Population	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Second-stage regression (Dependent variable is access to sanitation)						
Voice and accountability	0.323***	0.177**	0.241***	0.127*	0.423***	0.322**
	(0.079)	(0.076)	(0.073)	(0.067)	(0.090)	(0.126)
AR confidence intervals	[0.16, 0.50]	[0.06, 0.44]	[0.09, 0.39]	[0.01, 0.34]	[0.27, 0.65]	[0.15, 0.8]
log real GDP per capita		0.150***		0.117***		0.103
		(0.040)		(0.031)		(0.065)
log population density		-0.006		-0.017		0.004
		(0.016)		(0.014)		(0.024)
Panel B: First-stage regression (Dependent variable is voice)						
Mean years of schooling, 1900	0.826***	0.689***	0.823***	0.680***	0.823***	0.680***
	(0.172)	(0.204)	(0.172)	(0.204)	(0.172)	(0.204)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.412	0.750	0.520	0.780	0.105	0.410
Observations	73	72	72	71	72	71
F-stat of excl. instruments	23.01	11.36	22.84	11.17	22.84	11.17
Effective F-stat of excl. instruments	14.44	8.99	14.23	8.677	14.23	8.677
Kleibergen & Paap (2006) test (p-value)	0.009	0.007	0.009	0.007	0.009	0.007

Notes: *** and ** indicate significance at the 1% and 5% level. Robust standard errors in parentheses. AR confidence intervals correspond to the 95% Anderson-Rubin confidence intervals robust against weak instruments and heteroscedasticity. The *p-values* of the Kleibergen & Paap (2006) test correspond to a test in which the null hypothesis is that the equation is underidentified, and under the null, the statistic is distributed as chi-squared.

We begin by discussing the results in column 1 of Table 5, where we only include *Voice* and regional dummies in the model. The dummies of the regions included are Europe and Central Asia, Middle East and North Africa, East Asia and Pacific, Sub-Sahara Africa, Latin America and the Caribbean. The omitted group is South Asia. From column 1, we see that *Voice* has a large and positive effect on access to sanitation with a coefficient of 0.323, which is fairly precisely estimated, with standard error of 0.079. This results implies that a one unit increase in *Voice* increases access to sanitation by 32.3 percentage points. Furthermore, Panel B of the Table shows that our instrumental variable explains a large proportion of the variation in *Voice* and is statistically significant showing that there is a strong first-stage association with *Voice*. This suggests that our instrument passes the instrumental relevance test. The associated F-statistic and Effective F-statistic of excluded instrument are approximately 23 and 14, respectively. This is larger than the rule-of-thumb value of 10 (see Andrews et al., 2018). Furthermore, the AR confidence interval shows that the interval excludes a zero effect.

Column 2 in Table 5 reports the results from the specification that includes the control variables. The controls are the log income per capita and the log population density. Introducing these controls almost halves the coefficient of *voice* to 0.177 implying that a unit increase in *Voice* increases access to sanitation by 17.7 percentage points. The coefficient is also statistically significant at the 5% level and it is fairly precisely estimated, with standard errors of 0.076. Additionally, the first-stage regression in Panel B for column 2 shows that the coefficient of the instrumental variable is large and statistically significant. However, the associated F-statistic and the Effective F-statistic of excluded instrument are 11.36 and 8.99, respectively. These values are close to the Staiger and Stock (1997) rule-of-thumb value of 10 although the F-statistic is marginally greater than 10. Given the closeness of the Effective F statistic to the threshold value, we rely on the AR confidence interval for inference. The AR confidence interval clearly shows that the effect of *Voice* on basic sanitation service access and use exclude a zero effect.

Columns 3–6 in Table 5, present the results for urban and rural areas. The coefficient estimates on *Voice* is fairly large and statistically significant at least at the 10% level in all columns. A unit increase in voice and accountability causes an increase in access to sanitation by approximately 13 and 32 percentage points in urban and rural areas, respectively. The estimates suggest that the relationship between *Voice* and sanitation access is stronger in rural areas than in urban areas. Similar to the results for the full population, Panel B of the Table shows that the coefficient of the instrumental variable is large and statistically significant. The effective F-statistic for the even numbered columns (i.e., Columns 4 and 6) are smaller than the rule-of-thumb of 10. Hence, we again rely on the AR confidence interval for inference. The interval does not include a zero. We can therefore conclude that *Voice* has an unambiguous positive impact on broadening access to sanitation in the developing countries we consider. This implies that improvements in the populace's ability to actively participate in selecting governments, freedom of speech through protests, and strong and free press can help broaden access to sanitation in developing countries via the mechanisms previously discussed.

5.3 The rural-urban gap

As discussed earlier, there exists a significant rural-urban gap in access to sanitation in developing countries (Table 6). The results in Table 5 provides a preamble for the question of whether *Voice* can serve as an effective vehicle to help close this gap in access to sanitation. Specifically, Table 5 showed that while *Voice* has positive effect on access to sanitation in both rural and urban areas, the effect is generally larger in rural areas than in urban areas. In this section, we investigate whether *Voice* can help close this gap by regressing the gap, measured as the difference between the share of rural population with sanitation access and the share of urban population with sanitation access, on *Voice*.

Table 6: The effect of voice on the rural-urban gap

	(1)	(2)
Panel A: OLS estimates		
Voice and accountability	-0.029	-0.011
	(0.024)	(0.023)
Panel B: Two stage least squares estimates		
Voice and accountability	-0.1833***	-0.195**
	(0.057)	(0.082)
AR confidence intervals	[-0.344,-0.094]	[-0.503,-0.082]
Regional dummies	Yes	Yes
Other controls	No	Yes
Number of countries	72	72
First-stage Effective F-statistic	14.28	11.17
First-stage F-statistic	22.84	8.68
Kleibergen & Paap (2006) test (p value)	0.009	0.007

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses. AR confidence intervals correspond to the 95% Anderson-Rubin confidence intervals robust against weak instruments and heteroscedasticity. The p-values of the Kleibergen & Paap (2006) test correspond to a test in which the null hypothesis is that the equation is underidentified, and under the null, the statistic is distributed as chi-squared. *The dependent variable is rural-urban gap in access to sanitation*

Table 6 presents the results. We include the estimations from the OLS estimator for completeness. Two findings stand out. First, the estimates reveal that that there is a strong, negative, and statistically significant effect of *Voice* on the rural-urban gap. Increased *Voice* is likely to increase sanitation access and use in rural areas faster than it will be for urban areas, which generally may be nearing the upper limit of access (100%) hence, the gap is likely to close with increased *Voice*.[16] This suggests that improvement in institutions along the lines of which the populace have the ability to participate in selecting government and express freedom through associations and free media can narrow the rural-urban gap.

5.4 Robustness, validity, and sensitivity In this section we present robustness checks along the lines of sensitivity analysis and validity of our instrumental variable. We also present estimation results from the KLS estimator for both cross-section data and panel data. The latter allows as to control for time fixed effects.

5.4.1 Sensitivity analysis In this section, we conduct sensitivity analysis to ensure that the positive effect of *Voice* on access to sanitation is not driven by a set of outlier countries or a specific region. To this end, we re-estimate the model with data which exclude countries from one regional grouping at a time from the full sample.

Table 7: Sensitivity analysis on the effect of voice on access to sanitation

	Region Excluded in the Estimation					
	South Asia	EAP	MENA	EAP	SSA	LAC
Panel A: Second-stage regression (Dependent variable is access to sanitation)						
Voice and accountability	0.172**	0.214**	0.184**	0.158**	0.184*	0.137
	(0.075)	(0.094)	(0.080)	(0.065)	(0.104)	(0.097)
AR confidence intervals	[0.06, 0.43]	[0.08, 0.58]	[0.06, 0.46]	[0.05, 0.37]	[0.03, 0.59]	[-0.02, 0.52]
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	66	66	63	64	49	52
F-stat of excl. instruments	11.42	8.53	10.90	12.34	6.00	7.81
Effective F-stat of excl. instruments	8.70	7.91	7.92	10.43	5.39	5.16
Kleibergen & Paap test (p value)	0.007	0.012	0.008	0.005	0.026	0.075

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Robust standard errors in parentheses. AR confidence intervals correspond to the 95% Anderson-Rubin confidence intervals robust against weak instruments and heteroscedasticity. The *p*-values of the Kleibergen & Paap (2006) test correspond to a test in which the null hypothesis is that the equation is underidentified, and under the null, the statistic is distributed as chi-squared. ECA is Europe & Central Asia, MENA is Middle East & North Africa, East Asia & Pacific is EAP, sub-Saharan Africa is SSA, and Latin American and Caribbean is LAC.

Table 7 reports the estimates from the sensitivity exercise. All regressions include regional dummies and the standard control variables as in log GDP per capita and the log population density. The results show that there is sufficient evidence of a positive and statistically significant effect of *Voice* on access to sanitation when a region is excluded from the sample. Specifically, excluding countries in South Asia, Europe and Central Asia (ECA), Middle East and North Africa (MENA), East Asia and Pacific (EAP) or Sub-Sahara Africa (SSA) from the sample does not impact the positive effect or the statistical significance of the effect. However, when Latin America and Caribbean (LAC) countries are excluded from the sample, the coefficient remains positive but statistically insignificant. More importantly, the AR confidence include zero, suggesting that we can not rule out a zero effect for some regions in the sample. However, we note that the fact that five out of the six sensitivity exercise provide strong evidence in support of the conclusion that *Voice* increases the percentage of people using basic sanitation services is reassuring.

[16] After all, sanitation use in urban areas is getting close to the upper limit in most regions, hence can only grow slowly while low levels of access in rural areas imply that it can grow faster than in urban areas.

5.4.2 An instrument-free estimator

So far we have used instrumental variable estimation to establish a causal effect of *Voice* and accountability on access to sanitation. In this section, we apply a novel instrument-free non-parametric estimator, the kinky least squares (KLS) estimator, recently developed by Kiviet (2013, 2020, 2022). Before discussing the results, we provide a brief background on the estimator. The estimator is designed as a complement, and in scenarios where obtaining valid and relevant instrument is difficult, a viable alternative to the standard IV estimator.

The primary benefit of the KLS is that it is an instrument-free estimator under more relaxed assumptions. In the context of valid inference under conventional asymptotic theory, instrumental variables must be relevant and exogenous. The former condition requires that the instruments are sufficiently strongly correlated with the endogenous regressor(s) while the second condition requires that the instrument is directly related to the dependent variable (exclusion restriction) (Kripfganz and Kiviet, 2021). The KLS utilizes an identification strategy that does not rely on such exclusion restrictions but instead imposes assumptions on the degree of regressor endogeneity, which is left unrestricted in an IV estimation Kripfganz and Kiviet (2021). More precisely, the KLS makes use of a non-orthgonality condition for the endogenous regressor in the model, which is a function of the correlation coefficient between the endogenous regressor and the error term and the standard deviation of the endogenous variable and the error term in the regression (see, Kiviet, 2022; Kripfganz and Kiviet, 2021, for additional details). Consequently, for identification of the regression coefficient of the endogenous variable, the KLS restricts the plausible correlation of the regressor with the error term within plausible bounds. In this case, no excluded instruments are needed, and instead, the bias of the OLS estimator is analytically corrected for all values on a grid of endogeneity correlations (Kripfganz and Kiviet, 2021).

The KLS estimator is given by:

$$\beta_{1,KLS} = \beta_{1,OLS} - \text{Bias Correction}(\rho),$$

where ρ is the unknown correlation coefficient, $\beta_{1,KLS}$ is the KLS estimator, and $\beta_{1,OLS}$ is the standard OLS estimator, which is inconsistent when ρ is non-zero. The bias correction term, which is analytically derived and described in Kiviet (2020, 2022); Kripfganz and Kiviet (2021) is a function of ρ, the estimated variance of the OLS residual, the variance of the explanatory variable, covariance between the explanatory variable and the covariates.[17] The KLS estimator β_{KLS} coincides with the standard OLS estimator β_{OLS} if ρ is equal zero. To estimate β_{KLS}, the researcher has to postulate values for ρ, which includes the direction of bias of the OLS estimator. For a reasonably narrow range of postulated endogeneity correlations, the KLS confidence intervals are — as a general rule— narrower than those from 2SLS estimations, in particular if the instruments are relatively weak (Kripfganz and Kiviet, 2021). The KLS inference in this case can be more informative while avoiding the challenges associated with finding strong and valid external instruments. As described in Kripfganz and Kiviet (2021), the KLS approach enables testing of any potential exclusion restrictions, which is not plausible under a just-identified model like our model in section 5.

In our IV-estimation, it is evident that once we include the control variables in the specification, the standard F-statistic for the excluded instrument gets close to the rule-of-thumb value of 10. Furthermore, the effective F-statistics is consistently less than 10, although close, in several of the regressions. Although the robust AR confidence intervals

[17] See Kripfganz et al. (2021) and Kiviet (2020, 2022) for detailed discussion on the analytical derivation of the bias correction term. For exposition purposes we present the full mathematical representation of the KLS estimator in the appendix.

suggests that there may not be any issues related to weak instruments, the large differences between the OLS and IV estimates raises concerns other concerns of the relevance of the instruments.(Kiviet, 2020, 2022; Kripfganz and Kiviet, 2021).[18] As a first step, we employ the KLS estimator as an additional estimator to help reinforce our results. Because the KLS estimator does not rely on instruments, we are able to use it along with the 2SLS estimation to test for any potential exclusion restriction violation in our just-identified model. In particular, it allows the user to assess the validity of previously untestable just-identifying exclusion restrictions. The KLS estimator therefore serves as both a complement to the IV-estimation as well as a validation tool.

5.4.3 KLS RESULTS Because the correlation coefficient, ρ, is unknown, the KLS requires the postulation of admissible correlation of the regressors with the error term within plausible bounds. To do so, we combine information from the OLS and IV estimates in previous sections for guidance. The coefficients of *Voice* from the OLS and IV estimations in Tables 4 and 5 respectively suggest that the OLS estimator is downward biased in our case. To this end, we specify a negative sign for the correlation as well as a reasonable interval of -0.6 to -0.2 for the unknown correlation coefficient, ρ. Given that the KLS requires a postulated interval, as a more illuminating approach, the KLS plots the estimated coefficient with their corresponding 95% confidence intervals over the chosen range of endogeneity correlations (i.e., -0.6 to -0.2). This shows immediately for which values of the correlation coefficient we can reject (or not reject) the null hypothesis that a coefficient of interest equals a certain value. Furthermore, we are able to check whether the coefficient is statistically significantly different from zero. We also report formal exclusion test for our instrumental variable from postestimation tests from the KLS estimator.[19]

Figure 1 presents the results. The top row of the figure, Panels A and B, reports the estimates of the effect of *voice* on access to sanitation from the KLS estimator and the IV-regression. The light gray shaded area is the 95% confidence for the 2SLS estimator and the solid black line is the point estimate from the 2SLS estimator of *Voice*, $\beta_{1,IV}$. The dark gray shaded area in Panels A and B is the 95% confidence interval for the KLS estimate and the dashed lines are the KLS point estimates ($\beta_{1,KLS}$) of *Voice* corresponding to the postulated correlation coefficients given between -0.6 and -0.2. Panel A is the specification with no control variables and Panel B is the model with control variables. Both specifications include the regional dummies. The bottom figures, Panel C and D report the respective exclusion tests for the instrument used in the IV regressions in Panel A and B.

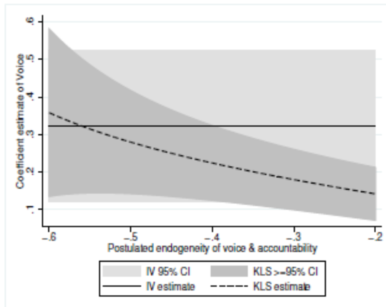
It is clear from panels A and B of figure 1 that for plausible range of the postulated values of the correlation coefficient, *Voice* has an unambiguous and statistically significant effect on access to sanitation. Two notable points need further highlighting: First, the effect of *Voice* from the KLS is decreasing in the postulated values of the correlation coefficient. Recall that the OLS estimates of the coefficient of voice and accountability are biased downwards. Hence, because the KLS estimator coincides with the OLS estimator at $\rho = 0$, it is intuitive to see that as the postulated endogeneity gets closer to zero, the KLS estimates of the effect of *Voice* will get closer to the OLS estimate.[20] Second, at approximately -0.56 and -0.52 for the postulated correlation coefficient in panel A and B, respectively, the estimates from the KLS coincides with the estimate from the 2SLS (i.e., $\beta_{1,KLS} = \beta_{1,IV}$). Additionally, for most of the postulated values, the KLS confidence lies within the confidence interval associated with the IV-estimation. This

[18]We thank Aart Kraay and S. Kripfganz for raising this issue. We intend on further investigating this issue and expanding the KLS postulated correlation interval to include positive correlation. The analysis is ongoing.

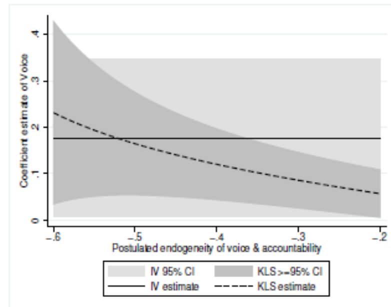
[19]We use the Stata command `kinkreg` developed by Kripfganz and Kiviet (2021) to implement the KLS estimations and postestimations.

[20]Indeed, Kripfganz and Kiviet (2021) show that the KLS estimator $\beta_{1,KLS}$ is by construction, point-symmetric around $\rho = 0$ and that $\beta_{1,KLS}$ is a monotonically decreasing function in ρ. See also Kiviet (2020) and Kiviet (2022) for additional details.

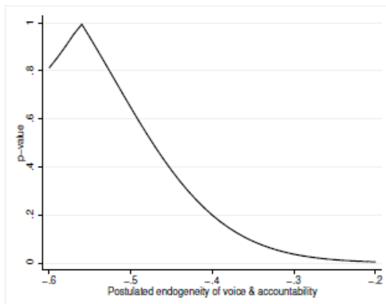
Figure 1: KLS estimation and validation of the effect of voice and accountability



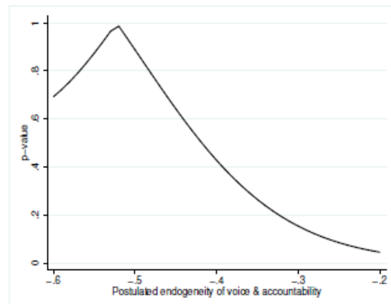
Panel A: Effect of voice and accountability on sanitation usage (Bivariate specification



Panel B: Effect of voice on sanitation usage (specification with controls



Panel C: *p*-values for the KLS exclusion restriction test of primary school enrollment



Panel D: *p*-values for the KLS exclusion restriction test of primary school enrollment

Notes: Panels A and B compare the KLS and 2SLS coefficient estimates and reports their corresponding 95% confidence intervals. The light gray shaded area is 95% confidence for the 2SLS estimator and the solid black line is the point estimate from the 2SLS estimator. The dark gray shaded area in Panels A and B is the 95% confidence for the KLS estimate and the dashed lines are the coefficient point estimates of voice and accountability corresponding to the postulated correlation coefficients given between -0.6 and -0.2. Panel C and D report the *p*-value for F-statistic for null hypothesis that the instrument (predicted loan disbursements) is validly excluded from the model. The instrument for the IV estimation in Panels A and B is the mean years of schooling in 1900.

reinforce the reliability of our results from the instrumental variable regressions in Table 5.

Finally, we provide a test of exclusion of our instrumental variable, average years of schooling in 1900. As discussed in Kripfganz and Kiviet (2021), effectively the KLS exclusion restriction test is asymptotically equivalent to a test of coefficient equality between the KLS and 2SLS estimates, assuming that our prior belief about the endogeneity correlation is correct. The *p*-values from Panel C and D, shows that for both model specifications we fail to reject the null hypothesis of the exclusion test implying that the instrument used is indeed a valid instrument. Interestingly, it can be observed from the figure that the point at which the *p*-value for the exclusion test for the instrument peaks corresponds to the point where the KLS and IV-estimate intersect. In general, the results show that KLS and the 2SLS estimators are both consistent. In summary, the KLS estimator reinforces our baseline results.

5.4.4 Panel Analysis with KLS In this section, we turn to using panel analysis, which allows us to consider both the cross-section and time dimension of the data. This further permits us to address important endogeneity issues. While the use of panel data offers richer insights into our key question, we do not have a relevant and valid time varying instrument hence, we can not utilize IV-type estimation. However, in the absence of a "good" instrument, we can employ the instrument-free KLS panel estimator for causal analysis. [21]

[21] It is worth mentioning that, instrument-free inference is not a panacea to the problems of instrument based methods (Kripfganz and Kiviet, 2021). It replaces one set of possibly strong though speculative assumptions with another set of relatively less restrictive conjectural

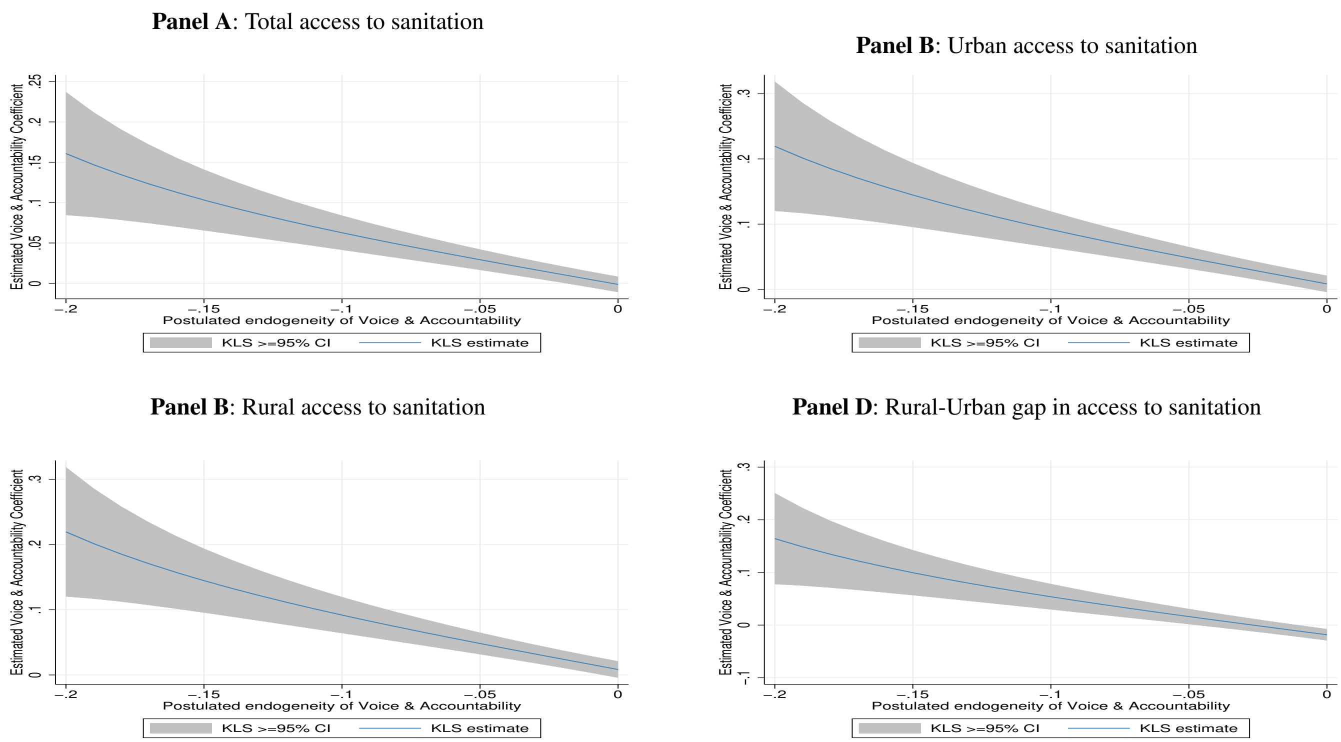
We have some prior information from the IV-KLS analysis from above that informs us about the sign of the endogeneity. The KLS estimates in Figure 1 suggests that the plausible range of the correlation coefficient lies approximately between -0.6 to -0.1; this also lies within the confidence interval of the IV estimates. For our panel estimation we specify a negative sign for the endogeneity coefficient, ρ, and restrict is to lie between zero and -0.2.[22]

We now estimate the panel data equivalent version of Equation 1 given as

$$S_{it} = \alpha_i + \delta t + \beta_1 \text{Voice}_{it} + \mathbf{X}_{it}^{\prime} \beta_2 + \varepsilon_{it}, \tag{2}$$

where the subscript i refers to countries and t refers to time in year, α_i and δ are country fixed-effects and time effects respectively, and all other variables as defined above.

Figure 2: KLS Panel-data estimates of the effect of voice & accountability on access to sanitation



Notes: The light gray shaded area in Panel A is the 95% confidence for the KLS estimate and the solid blue line is the coefficient point estimates of voice and accountability corresponding to the postulated correlation coefficient, ρ set between -0.2 and 0. We control for country-specific effects and time-specific effect. The estimation comprise 73 countries over the period 2002-2020 with a total number of observation of 1,378.

Figure 2 depicts the results for the KLS panel estimates. For the admissible range of correlation coefficients ($\rho < 0$), we find strong evidence that *Voice* has a positive and statistically significant impact on access to sanitation (Panel A, B, and C). Additionally, Panel D in the figure shows that *Voice* helps to close the rural-urban gap in access to sanitation. These panel-data results complements the findings from the cross-sectional analysis.

assumptions. As pointed out by the authors, in several applications, it might be easier to specify a credible range for the correlation of an endogenous regressor with the error term than to convincingly present strong and valid instruments. However, on one hand, if the postulated endogeneity range is too narrow, it may not include the true correlation value, potentially leading to serious bias. In contrast, if it is too wide, the resulting confidence intervals could be less informative than those from a 2SLS estimation with strong and valid instruments.

[22] We conduct preliminary estimation with ρ specified between (-0.6, 0). We found that the corresponding confidence intervals for ρ values less than -0.25 are extremely wide. We therefore rule out these values for the purpose of inference.

6. Conclusion and policy discussion

Globally, 2.4 billion people live without access to basic sanitation. Developing countries also face serious governance challenges due to weak political institutions and processes. In this paper, we estimate the causal effect of voice and accountability, characterized broadly as transparent electoral processes, free media, and freedom of expression, on access to sanitation. Our core argument is that voice and accountability increase sanitation's visibility as a public good and raise awareness of its benefits, thereby increasing the supply and demand for sanitation services and access to sanitation. In a cross-section of 73 developing countries, we find a positive and economically significant effect of voice and accountability on access to sanitation. Importantly, voice and accountability can be used as an effective vehicle to close the persistent rural-urban inequality in access to sanitation. Our findings reinforce the argument that the institutionalization of monitoring and evaluation systems for sanitation delivery that sufficiently relies on citizens' voices and perceptions is not a luxury of the rich. Instead, it is relevant to the world's poor as its tenets, like the power of electoral incentives and free media, can shape the demand and distribution of sanitation services.

Our results are consistent with the results of previous research that finds that increased resources and education increases access to and use of sanitation services. However, our results are also different from the results of previous research. This is one of the few studies that establishes a causal relationship between voice and accountability and access to and use of sanitation services. While most research on sanitation provision focuses on the effects of external aid to increase the demand for and supply of sanitation, this study focuses on free media, freedom of expression, and accountability as the drivers of increased provision and use of sanitation. In this regard, increased access to and use of sanitation can be seen as the results of domestic institution building, hence more durable than the oft reliance on external aid.

This paper analyzed access to and use of sanitation as the results of a combination of supply and demand forces. In the empirical analyses, we did not distinguish between demand side effects and supply side effects; distinctions that may be important in policy formulation and implementation. In the robustness exercise, we extend our analysis to panel data to capture the relevance of the time dimension in the relationship in question. Our baseline empirical analyses (i.e., the instrumental variable estimation) was based on cross-country data; hence, we were not able to analyze how the relationship between voice and accountability and sanitation use across countries changed over time. Such changes could be potentially important and significantly affect our results. Our results should therefore be interpreted with these caveats.

REFERENCES

ABELLÁN, J. AND J. A. ALONSO (2022): "Promoting global access to water and sanitation: A supply and demand perspective," *Water Resources and Economics*, 38, 100194.

ADIL, S., M. NADEEM, AND I. MALIK (2021): "Exploring the important determinants of access to safe drinking water and improved sanitation in Punjab, Pakistan," *Water Policy*, 23, 970–984.

ADUKIA, A. (2017): "Sanitation and Education," *American Economic Journal: Applied Economics*, 9, 23–59.

ALEXANDER, C. C., S. SHRESTHA, M. D. TOUNKARA, S. COOPER, L. HUNT, T. H. HOJ, K. DEARDEN, D. KEZAKUBI, V. ATUGONZA, J. WEST, ET AL. (2019): "Media access is associated with knowledge of optimal water, sanitation and hygiene practices in Tanzania," *International journal of environmental research and public health*, 16, 1963.

ALZÚA, M. L., H. DJEBBARI, AND A. J. PICKERING (2020): "A community-based program promotes sanitation," *Economic Development and Cultural Change*, 68, 357–390.

ANBARCI, N., M. ESCALERAS, AND C. REGISTER (2009): "The Ill Effects of Public Sector Corruption in the Water and Sanitation Sector," *Land Economics*, 85, 363–377.

ANDREWS, I., S. JAMES, S. LIYANG, ET AL. (2018): "Weak Instruments in IV Regression: Theory and Practice," *Annual Review of Economics*.

ASHRAF, N., E. L. GLAESER, AND G. A. PONZETTO (2016): "Infrastructure, incentives, and institutions," *American Economic Review*, 106, 77–82.

BATLEY, R. AND C. MCLOUGHLIN (2015): "The Politics of Public Services: A Service Characteristics Approach," *World Development*, 74, 275–285.

BERKOUWER, S. B. AND J. T. DEAN (2022): "Credit, attention, and externalities in the adoption of energy efficient technologies by low-income households," *American Economic Review*, 112, 3291–3330.

BREEN, M. AND R. GILLANDERS (2022): "Money down the drain: Corruption and water service quality in Africa," *Governance*.

DEACON, R. T. (2009): "Public good provision under dictatorship and democracy," *Public choice*, 139, 241–262.

FRANCOIS, J. N., J. KAKEU, AND C. KOUAME (2021): "Do Better Institutions Broaden Access To Sanitation In Sub-Sahara Africa?" *Contemporary Economic Policy*, 39, 435–452.

GAUTAM, S. (2023): "Quantifying welfare effects in the presence of externalities: An ex-ante evaluation of sanitation interventions," *Journal of Development Economics*, 103083.

GLAESER, E. L., G. A. PONZETTO, AND A. SHLEIFER (2007): "Why does democracy need education?" *Journal of Economic Growth*, 12, 77–99.

GOPALAN, S. AND R. S. RAJAN (2016): "Has foreign aid been effective in the water supply and sanitation sector? Evidence from panel data," *World Development*, 85, 84–104.

GYIMAH-BREMPONG, K. AND S. M. DE CAMACHO (2006): "Corruption, growth, and income distribution: Are there regional differences?" *Economics of Governance*, 7, 245–269.

HEPWORTH, N., T. BREWER, B. BROWN, M. ATELA, J. KATOMERO, J. KONES, AND M. GASHAW (2022): "Accountability and advocacy interventions in the water sector: a global evidence review," *H2Open Journal*.

HOUT, W., N. WAGNER, AND B. A. DEMENA (2022): "Does accountability enhance service delivery? Assessment of a local scorecard initiative in Uganda," *World Development*, 158, 106011.

IMMURANA, M., A.-A. IDDRISU, Z. MOHAMMED, AND T. J. MATHEW KK (2022): "Access to basic drinking water and sanitation in Africa: Does financial inclusion matter?" *Cogent Social Sciences*, 8, 2057057.

KAUFMANN, D., A. KRAAY, AND M. MASTRUZZI (2011): "The worldwide governance indicators: methodology and analytical issues," *Hague Journal on the Rule of Law*, 3, 220–246.

KAUFMANN, D., G. MEHREZ, AND T. GURGUR (2019): "Voice or public sector management? An empirical investigation of determinants of public sector performance based on a survey of public officials," *Journal of Applied Economics*, 22, 321–348.

KEEFER, P. AND S. KHEMANI (2005): "Democracy, public expenditures, and the poor: understanding political incentives for providing public services," *The World Bank Research Observer*, 20, 1–27.

KHEMANI, S. (2015): "Buying votes versus supplying public services: Political incentives to under-invest in pro-poor policies," *Journal of Development Economics*, 117, 84–93.

KIVIET, J. F. (2013): "Identification and inference in a simultaneous equation under alternative information sets and sampling schemes," *The Econometrics Journal*, 16, S24–S59.

——— (2020): "Testing the impossible: identifying exclusion restrictions," *Journal of Econometrics*, 218, 294–316.

——— (2022): "Instrument-free inference under confined regressor endogeneity and mild regularity," *Econometrics and Statistics*.

KRIPFGANZ, S. AND J. F. KIVIET (2021): "kinkyreg: Instrument-free inference for linear regression models with endogenous regressors," *The Stata Journal*, 21, 772–813.

KRIPFGANZ, S., J. F. KIVIET, ET AL. (2021): "kinkyreg: Instrument-free inference for linear regression models with endogenous regressors," *Stata Journal*, Forthcoming.

LEGGE, H., K. E. HALLIDAY, S. KEPHA, C. MCHARO, S. S. WITEK-MCMANUS, H. EL-BUSAIDY, R. MUENDO, T. SAFARI, C. S. MWANDAWIRO, S. H. MATENDECHERO, ET AL. (2021): "Patterns and Drivers of Household Sanitation Access and Sustainability in Kwale County, Kenya," *Environmental Science & Technology*, 55, 6052–6064.

LUTZ, W., J. C. CUARESMA, AND M. J. ABBASI-SHAVAZI (2010): "Demography, education, and democracy: Global trends and the case of Iran," *Population and Development Review*, 36, 253–281.

MANI, A. AND S. MUKAND (2007): "Democracy, visibility and public good provision," *Journal of Development Economics*, 83, 506–529.

MAURO, P. (1998): "Corruption and the composition of government expenditure," *Journal of Public economics*, 69, 263–279.

MUNAMATI, M., I. NHAPI, AND S. MISI (2016): "Exploring the determinants of sanitation success in Sub-Saharan Africa," *Water Research*, 103, 435–443.

NARZETTI, D. AND R. MARQUES (2021): "Access to Water and Sanitation Services in Brazilian Vulnerable Areas: The Role of Regulation and Recent Institutional Reform," *Water*, 13, 787.

NDIKUMANA, L. AND L. PICKBOURN (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.

PAKHTIGIAN, E. L., K. L. DICKINSON, J. ORGILL-MEYER, AND S. K. PATTANAYAK (2022): "Sustaining latrine use: Peers, policies, and sanitation behaviors," *Journal of Economic Behavior & Organization*, 200, 223–242.

PICKBOURN, L., R. CARAHER, AND L. NDIKUMANA (2022): "Does project-level foreign aid increase access to improved water sources? Evidence from household panel data in Uganda," *World Development*, 158, 105994.

RAVILLA, T., S. KARUMANCHI, AND T. DAS (2021): "Health Management and Information: Key Principles and Enablers in Eye Health Program," in *South-East Asia Eye Health*, Springer, 23–50.

RODRIK, D., A. SUBRAMANIAN, AND F. TREBBI (2004): "Institutions rule: the primacy of institutions over geography and integration in economic development," *Journal of economic growth*, 9, 131–165.

SPEARS, D. AND S. LAMBA (2016): "Effects of Early-Life Exposure to Sanitation on Childhood Cognitive Skills: Evidence from India's Total Sanitation Campaign," *The Journal of Human Resources*, 51, 298–327.

STAIGER, D. AND J. STOCK (1997): "Instrumental Variables Regression with Weak Instruments," *Econometrica*, 65, 557–586.

UNITED NATIONS (2021): "Transformational benefits' of ending outdoor defecation: Why toilets matter," *UN News Global Perspective Human stories*, available at: https://www.worldbank.org/en/topic/sanitation#1.

A. An illustrative model: voice and sanitation delivery services

We present a stylized model with an analytical solution that captures the relationship amongst visibility of public good, voice and accountability, and access to sanitation.

Our framework borrows from the works by Batley and Mcloughlin (2015); Keefer and Khemani (2005); Mani and Mukand (2007) in applying the concept of visibility of a public good to address the issue of public provision of sanitation services in a country where there is an elective political process for the choice of a high official who make decisions on behalf of the people. The modeling approach strengthens our understanding of the political incentives and economic mechanisms associated with the quality of institutions and stakeholder interests in the delivery of sanitation services. Low visibility refers to the idea that the more obscured from the public view are the processes and outputs of sanitation services to citizen, the more it can reduce political incentives for provision of sanitation services. In fact, the visibility issue ties in directly with weak institution, particularly, in developing countries. Specifically, governments in developing countries lack the institutions and political will to make sanitation a priority—i.e., sanitation tends to be an "institutional orphan" as government official often avoid responsibility for the sector that many feel uncomfortable discussing.[23]

The incentives of politicians to provide sanitation services vary across countries. There is ongoing concern that governments in sub-Saharan Africa are not devoting enough attention and resources to the delivery of basic sanitation services, particularly when compared to spending on other infrastructure services. The potential political returns from producing low visible sanitation outputs may be viewed as lower than those from tackling higher profile challenges that are not obscured from public view. For instance, investing in physical buildings and infrastructure are inherently more "noisy signals" of political effort than investing in less visible services like basic sanitation services (Batley and Mcloughlin, 2015; Keefer and Khemani, 2005). Invisibility of basic sanitation provision and maintenance can lead politicians to under-invest in sanitation services the long-run. Furthermore, low visibility public goods such as sanitation are likely to get less voter and political attention than famine relief or defense during war (Mani and Mukand, 2007). Low visibility can be viewed as a persistent political constraints to effective delivery of sanitation services, as they underscore weak political commitment. In what follows we present a striped down tractable economic model to identify stakeholder interests and institutional determinants of political economy of sanitation delivery.

The incumbent government's delivery of sanitation services This model is an adaptation of the framework by Mani and Mukand (2007) to the issue of sanitation service delivery with political incentives. We consider a country where an incumbent government is responsible for the provision of sanitation services.

There are often unobservable non-policy factors that may affect how citizens evaluate the process leading to the delivery of sanitation services in a country. An example of these unobservable factors include lack of adequate information on what the role of government is in providing sanitation services, which creates an uncertainty on the role of government from the citizens perspective. The citizen voter therefore may understand sanitation delivery outcomes as a combined result not only of active policy components (i.e., efforts and competency of elective officials) but also other random non-policy societal factors represented by a normal distribution. The higher the magnitude of uncertainty surrounding the role played by non-policy factors, the lower will be the visibility of government actions in providing sanitation services which in turn will affect the electoral decisions of citizens. For instance, if the magnitude

[23] See http://www.ledevoir.com/documents/pdf/rapporteau.pdf for details.

of uncertainty surrounding non-policy factors is very high, that would lower the citizens' perceived role attributed to the incumbent government in providing sanitation services. In contrast, in a world where there is no uncertainty surrounding non-policy societal factors, citizens would be able fully access the role and the magnitude of policy factors involved in the delivery process of sanitation services. More formally, the incumbent government's delivery of sanitation services is perceived by a citizen-voter as follows

$$\mathscr{S}_t = \tau + g_t + \varepsilon, \tag{A.1}$$

which includes the government's effectiveness τ, the incumbent government's resource allocation, g_t, and random societal factors whose likelihood is measured by a normal distribution $\varepsilon \sim N(0, \sigma_\varepsilon(D))$.[24] The magnitude of the impact of the random societal factors on the process of sanitation delivery is given by the standard deviation function $\sigma_\varepsilon(D)$ where D is a parameter that broadly captures the quality of the monitoring system by the people, free media that actively informs the citizens about the role of government, the quality of electoral rules, and transparent elections. This variable is proxied by *voice and accountability* in our empirical estimation. We assume that $\sigma'_\varepsilon(D) < 0$, implying that an increase in D reduces uncertainty surrounding the role of government in sanitation delivery services. Intuitively, a stronger media that can raise awareness about sanitation services, better monitoring system by the people and/or greater transparency in the election rule reduces the perceived uncertainty played by other societal factors. For simplicity, we assume that ε also captures demand factors that government takes as given in its decisions on sanitation delivery services.

It is assumed that the true ability of the incumbent government τ is not known to anyone, including the government itself. However, there is a common prior that the government's competence or effectiveness is drawn from a normal distribution $\tau \sim N(\bar{\tau}, \sigma_\tau^2)$ with mean $\bar{\tau}$ and variance σ_τ^2. There is a cost $C(g_t)$ associated with providing sanitation services delivery, where the cost function is assumed to be twice continuously differentiable. We assume that the precise allocation g_t is not observable to the citizens, which can be viewed from the perspective of a developing country where voter illiteracy, corruption and a lack of transparency are rife.[25] Indeed, even if published, information on public good expenditures are notoriously unreliable in developing countries.

CITIZENS' APPRECIATION OF THE INCUMBENT GOVERNMENT'S EFFORTS AND COMPETENCE The economy contains citizens of unit mass who derive utility from consuming sanitation services. The citizen-voter preferences for sanitation services are identical, such that

$$U_t = u(\mathscr{S}_t) \tag{A.2}$$

where u is an increasing and concave function. The citizen-voters do not know the incumbent government's ability *ex ante*, but they can update their assessment of its ability by examining its performance in providing sanitation service outputs. Ceteris paribus, a higher realized sanitation service outputs results in the citizen-voter having a more favorable perception of the government's ability and hence, improves the latter's chances of remaining in power. This suggests that resources g are a substitute for the ability τ. It implies that an increased allocation of resources by a government

[24] In the model g_t can be viewed as the stock of accumulated expenditures up to time t so that $\mathscr{S}_t$ represents the net stock of sanitation services up to time t, after taking into account the depreciation of sanitation infrastructure. For tractability, the model is simplified to two periods. In the first period, the incumbent has to make a decision that will influence the voter decision in the next period. The first period current government spending can be viewed as a proxy of the accumulated stock of previous expenditures.

[25] In the context of literacy rate, adult total (% of people ages 15 and above), SSA ranks lowest among the world developing regions. See https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?end=2010&locations=ZG-1W-Z4-8S-Z7-ZJ&start=2010&view=bar for details. See also Gyimah-Brempong and de Camacho (2006) for the case of corruption.

can favorably affect the citizen-voter's inference of its ability. This suggests that a government interested in enhancing its reputation may have a low incentive in investing high level resources in favor of sanitation delivery services if they are perceived as having a very low impact on the people's inference.

QUALITY OF VOICE AND ACCOUNTABILITY Typically, the more democratic a country is, the more sensitive the government is to the citizens' perception of its competence. The parameter D is the likelihood that transparent elections accounting for voice and accountability are held at the end of the first period. D can also broadly comprise free media and freedom of speech. However, for the purposes of highlighting the direct role of voice and accountability in stimulating government's ability to increase the supply of sanitation services, we limit the definition of D to free and fair elections. Hence, D represents the degree to which the incumbent's ability to retain power in the second period depends on the citizen's votes as related to their perception of its competence. A greater likelihood of transparent and fair elections (higher D) implies that the government will have to put in effort to maximize its reputation for competence among citizens. The parameter D can also be viewed as a measure of the quality of political institutions, which governs the process of collective decision-making in society.

RE-LECTION PROBABILITY ψ OF THE INCUMBENT GOVERNMENT Define $\psi(\mathscr{S})$ as the probability that incumbent government retains power and enjoy "ego" rents R when the realized provision of sanitation services is $\mathscr{S}$. With no elections, (probability (1-D)), it remains in power for sure, independent of its reputation and enjoys the same "ego' rents from doing so for a second period. There is a "charisma" factor that citizens care about in their electoral decisions, which may be related to the ethnicity of the candidates. We represent the charisma of the challenger, relative to the incumbent, by a variable c drawn from a uniform law as follows $c \sim U[-c_0, c_0]$. It is realized immediately prior to the elections after the incumbent has made the first period resource allocation decision. If the voter's estimate of the incumbent's ability is greater than $\bar{\tau} + c$, she votes to retain the incumbent. If not, the incumbent must leave office at the end of period one.

The government's efforts on sanitation services are driven by the fact that it wants to stay on in power. The voter's re-election decision depends on two factors: the competence and the charisma of the incumbent, relative to those of the challenger. We denote by g^* citizen's expectation of how much effort has been allocated by the incumbent government for delivering sanitation services. The citizen-voter compares his updated estimate of the perceived competence, $E(\tau|\mathscr{S}, g^*)$ with its *ex ante* estimate of a randomly drawn challenger's competence, c. In addition, the voter takes into account the realization of the challenger's charisma c, which proxies for the all nonability related stochastic factors that may influence elections. The incumbent is re-elected if the following citizen-voters' condition is satisfied

$$E(\tau|\mathscr{S}, g^*) - \bar{\tau} \geq c$$

For instance, if c is positive, the incumbent should have a sufficiently higher than average reputation to offset its "charisma" deficit. The incumbent government makes resource allocation decisions with a view to maximizing his probability of re-election ψ. In electoral equilibrium, we have

$$\psi(\mathscr{S}) \underbrace{=}_{\text{Rational expectations condition}} \text{Probability}\Big[E(\tau|\mathscr{S},g^*)-\bar{\tau}\geq c\Big] \tag{A.3}$$

$$= \frac{1}{2c_0}\int_{-c_0}^{E(\tau|,\mathscr{S},g^*)-\bar{\tau}} dx \tag{A.4}$$

$$= \frac{1}{2c_0}[E(\tau|\mathscr{S},g^*)-\bar{\tau}+c_0]] \tag{A.5}$$

As shown in Mani and Mukand (2007), the Bayes's rule can be used to compute the citizen-voter's perceived competence of the incumbent government as follows:

$$E(\tau|\mathscr{S},g^*) = \left[\frac{\frac{1}{\sigma_\tau^2}+\frac{1}{\sigma_\varepsilon^2(D)}(\mathscr{S}-g^*)}{\frac{1}{\sigma_\tau^2}+\frac{1}{\sigma_\varepsilon^2(D)}}\right] \tag{A.6}$$

The government's discount factor is β and the objective is to solve the maximization problem

$$\max_g \left\{ \underbrace{R}_{\text{Value of holding office}} - \underbrace{C(g)}_{\text{Sanitation delivery costs}} + \underbrace{\frac{1}{1+\beta}\left[R(1-D)+RD\frac{1}{2c_0}[E(E(\tau|\mathscr{S},g^*))-\bar{\tau}+c_0]]\right]}_{\text{Expected value of winning a second term in office}} \right\} \tag{A.7}$$

Using the fact that $E(\mathscr{S})=\bar{\tau}+e$, the expression $E(E(\tau|\mathscr{S},g^*))$ can be computed (see, Mani and Mukand (2007)) as follows

$$E(E(\tau|\mathscr{S},g^*)) = \left[\frac{\frac{1}{\sigma_\tau^2}+\frac{1}{\sigma_\varepsilon^2(D)}(\bar{\tau}+g-g^*)}{\frac{1}{\sigma_\tau^2}+\frac{1}{\sigma_\varepsilon^2(D)}}\right] \tag{A.8}$$

Plugging (A.8) in equation (A.9) leads to

$$\max_g \left\{ R-C(g)+\frac{1}{1+\beta}\left[R(1-D)+RD\frac{1}{2c_0}\left[\left[\frac{\frac{1}{\sigma_\tau^2}+\frac{1}{\sigma_\varepsilon^2(D)}(\bar{\tau}+g-g^*)}{\frac{1}{\sigma_\tau^2}+\frac{1}{\sigma_\varepsilon^2(D)}}\right]-\bar{\tau}+c_0\right]\right]\right\} \tag{A.9}$$

EQUILIBRIUM DELIVERY OF SANITATION SERVICES The objective function is concave with respect to efforts allocated to sanitation survives. Computing the first order condition shows that the optimal effort satisfies the following the relation

$$g = C'^{-1}\left(\frac{RD}{2c_0(1+\beta)}\frac{\sigma_\tau^2}{\sigma_\varepsilon^2(D)+\sigma_\tau^2}\right) \tag{A.10}$$

It is straightforward to show that

$$\frac{\partial g}{\partial D} > 0 \tag{A.11}$$

Equation (A.11) highlights that a higher probability of having transparent and fair elections, free media, and stronger accountability of government lead the incumbent government to increase the delivery of sanitation services, $\mathscr{S}_t$.

B. Mathematical representation of the KLS estimator

Since the KLS is a relatively new estimator, which we are applying to our empirical model, and for convenience, we provide the details of the KLS estimator derived and desribed in Kiviet (2020, 2022); Kripfganz and Kiviet (2021) as applied to our model. Our model is given as,

$$S_i = \beta_1 \text{Voice}_i + \mathbf{X}_i^{'} \boldsymbol{\beta}_2 + \varepsilon_i \tag{B.1}$$

The kinkreg command in STATA, which implements the KLS automatically transforms all variables into deviations from the means; hence, the intercept, α is partialled out of from the model. The KLS estimator is instrument-free and Kiviet (2020, 2022) suggests an approach that makes use of a non-orthogonality condition for the endogenous regressor, which in our model is Voice: $E[\text{Voice}_i \varepsilon_i] = \rho \sigma_1 \sigma \varepsilon$, where as discussed earlier ρ is the correlation coefficient between Voice and ε, and σ_1 and σ_ε are the standard deviations for Voice and ε, respectively. As shown in Kiviet (2020, 2022) the standard deviations can be estimated from the observed data. However, ρ is unknown and has to be carefully postulated by the researcher in order to uncover the KLS estimator. Usually, a desirable interval is postulated for ρ instead of a single value. This way, there is a higher likelihood that ρ falls with the given interval.

With the assumption that the interval for ρ has been correctly postulated, the KLS estimator as derived in Kiviet (2020, 2022); Kripfganz and Kiviet (2021) is given by

$$\begin{pmatrix} \hat{\beta}_{1,KLS} \\ \hat{\boldsymbol{\beta}}_{2,KLS} \end{pmatrix} = \begin{pmatrix} \hat{\beta}_{1,OLS} \\ \hat{\boldsymbol{\beta}}_{2,OLS} \end{pmatrix} - \underbrace{\frac{\rho \hat{\sigma}_1 \hat{\sigma}_\varepsilon(\rho)}{\hat{\sigma}_1^2 - \hat{\boldsymbol{\sigma}}_{12}^{'} \hat{\boldsymbol{\Sigma}}_2^{-1} \hat{\boldsymbol{\sigma}}_{12}} \begin{pmatrix} 1 \\ -\hat{\boldsymbol{\Sigma}}_2^{-1} \hat{\boldsymbol{\sigma}}_{12} \end{pmatrix}}_{\text{Bias Correction}(\rho)\text{or adjustment term}} \tag{B.2}$$

where the bias correction term is also a function of the coviarance estimates $\boldsymbol{\sigma}$ and variance, $\boldsymbol{\Sigma}$ both of which can be readily estimated from the data. There are a few features of the KLS estimator that need highlighting: First, the KLS estimator is point-symmetric around $\rho = 0$, and $\hat{\beta}_{1,KLS}$ is monotonically decreasing function in ρ. $\hat{\beta}_{1,KLS}$ coincides with the OLS estimator if ρ is zero. On the other hand, $\hat{\boldsymbol{\beta}}_{2,KLS}$ is monotonically increasing or decreasing, depending on the covariance terms. $\hat{\beta}_{1,KLS}$ coincides with the OLS estimator if ρ is zero or if $\mathbf{X}_i^{'}$ are exogenous and uncorrelated with the endogenous regressor, Voice_i (i.e., $\boldsymbol{\sigma}_{12} = 0$). For additional and in-depth derivation of the KLS estimator, the interested reader should see Kiviet (2020, 2022); Kripfganz and Kiviet (2021) for details.