FUNDING A WATER-SECURE FUTURE

An Assessment of Global Public Spending

George Joseph, Yi Rong Hoo, Qiao Wang,
Aroha Bahuguna, and Luis Andres

WORLD BANK GROUP

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KEY FINDINGS

NEARLY $165 BILLION IS SPENT ON WATER ANNUALLY

$164.6 billion

Annual Spending in the Water Sector

Public spending makes up about 85.5% of the spending in the water sector. The **private sector** constitutes less than 2 percent.

THE PUBLIC SECTOR DOMINATES SPENDING ON WATER

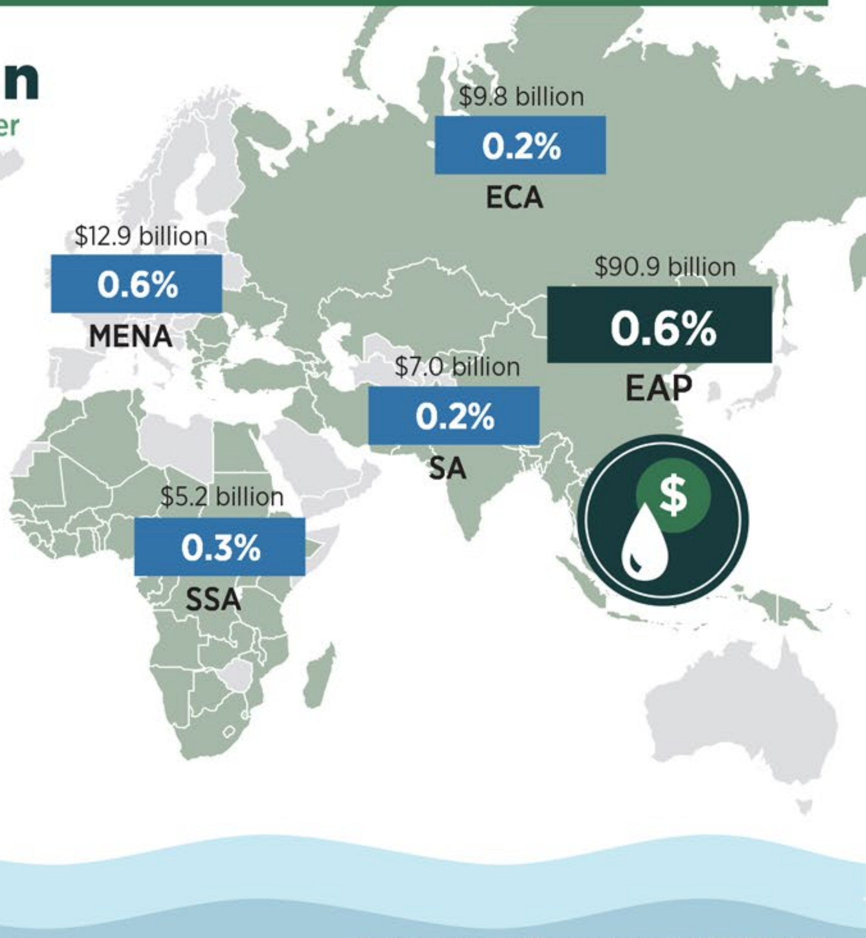
$140.7 billion

Annual Public Spending in Water

0.5%

Total GDP

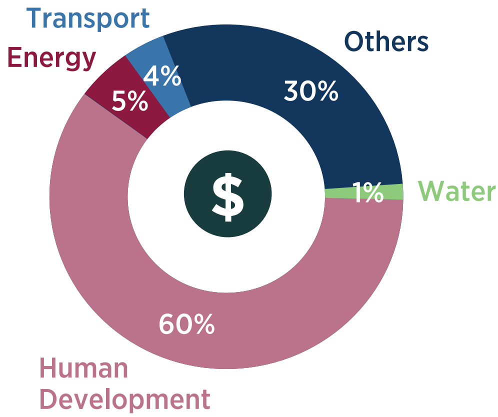
EAP constitutes a large portion of the public spending in water at **$90.9 billion**.



*Model estimates for 130 countries based on BOOST in 2017 constant prices. Values as a share of GDP are presented in boxes.

PUBLIC SPENDING ON WATER IS LOWER THAN OTHER SECTORS

COMPARISON WITH OTHER SECTORS (2009-20)



Only...

1.2%

of Public Spending

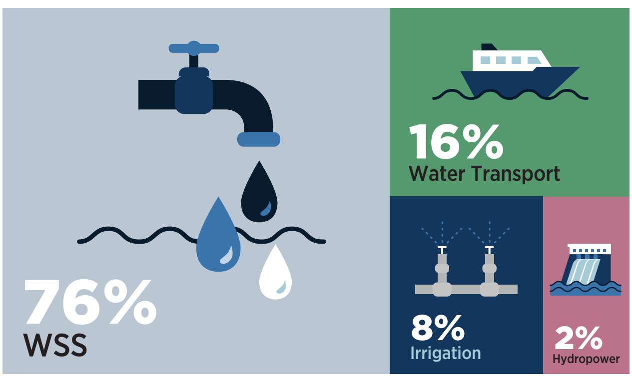
is spent in the **water sector.**

Among infrastructure sectors, public spending in water is **lower** than that of in **transport** and **energy** sectors.

*Based on available budget data for 68 countries. Telecommunications not included: 0.2%.

MOST OF THE PUBLIC SPENDING ON WATER GOES TO WSS

BY SUBSECTORS (2009-20)



76%

of Public Spending in Water

goes to WSS

Public spending in **Water Supply and Sanitation (WSS)** constitutes the **bulk** of public spending in the water sector, followed by water transportation.

*Based on available budget data for 68 countries.

DOMESTIC FUNDS ARE THE MAIN SOURCE OF PUBLIC SPENDING

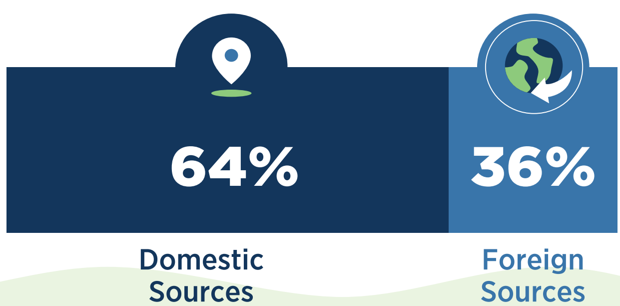
64%

of Public Spending in Water

is funded by domestic sources

Although **foreign funding** is important for **Sub-Saharan Africa.**

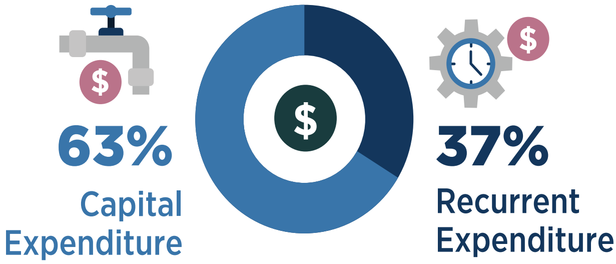
BY FUNDING SOURCES (2009-20)



*Based on available budget data for 68 countries.

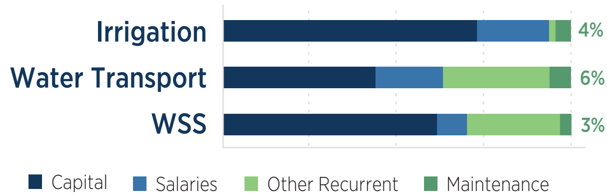
SPENDING IS CAPITAL INTENSIVE BUT MAINTENANCE IS LOW

CAPITAL VS RECURRENT (2009-20)



*Based on available budget data for 68 countries.

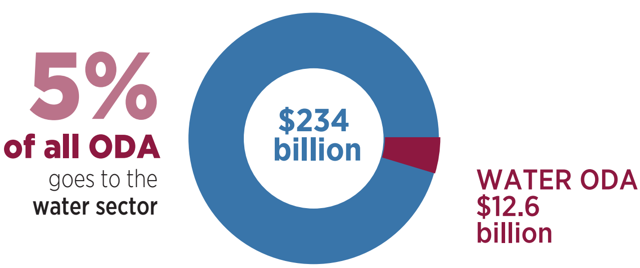
LOW MAINTENANCE SPENDING (2009-20)



Spending on maintenance is less than 7% of total spending across the water subsectors. It includes both **capital** and **recurrent** maintenance.

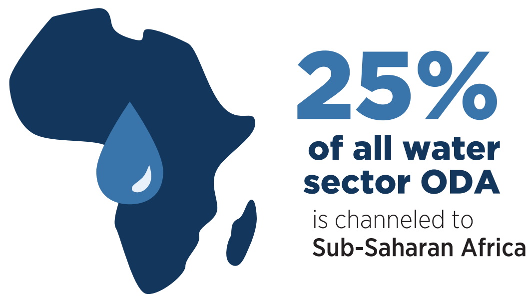
ODA IN WATER IS LOW OVERALL BUT LARGE FOR SSA

AVERAGE ODA (2011-19)



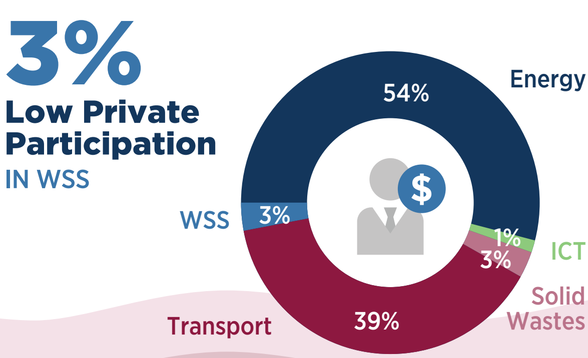
*Based on available data for 153 countries. Total ODA includes Other Official Flows (OOF).

WATER ODA IN SSA (2011-19)



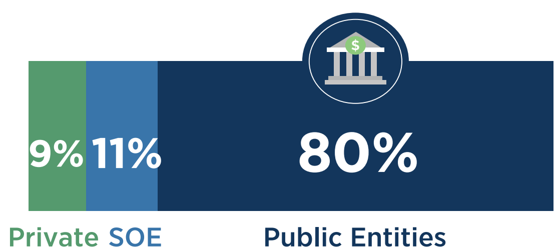
PRIVATE PARTICIPATION IN WSS IS LOW

PRIVATE SECTOR INFRASTRUCTURE INVESTMENTS BY SECTORS (2009-20)



*Based on available project level database.

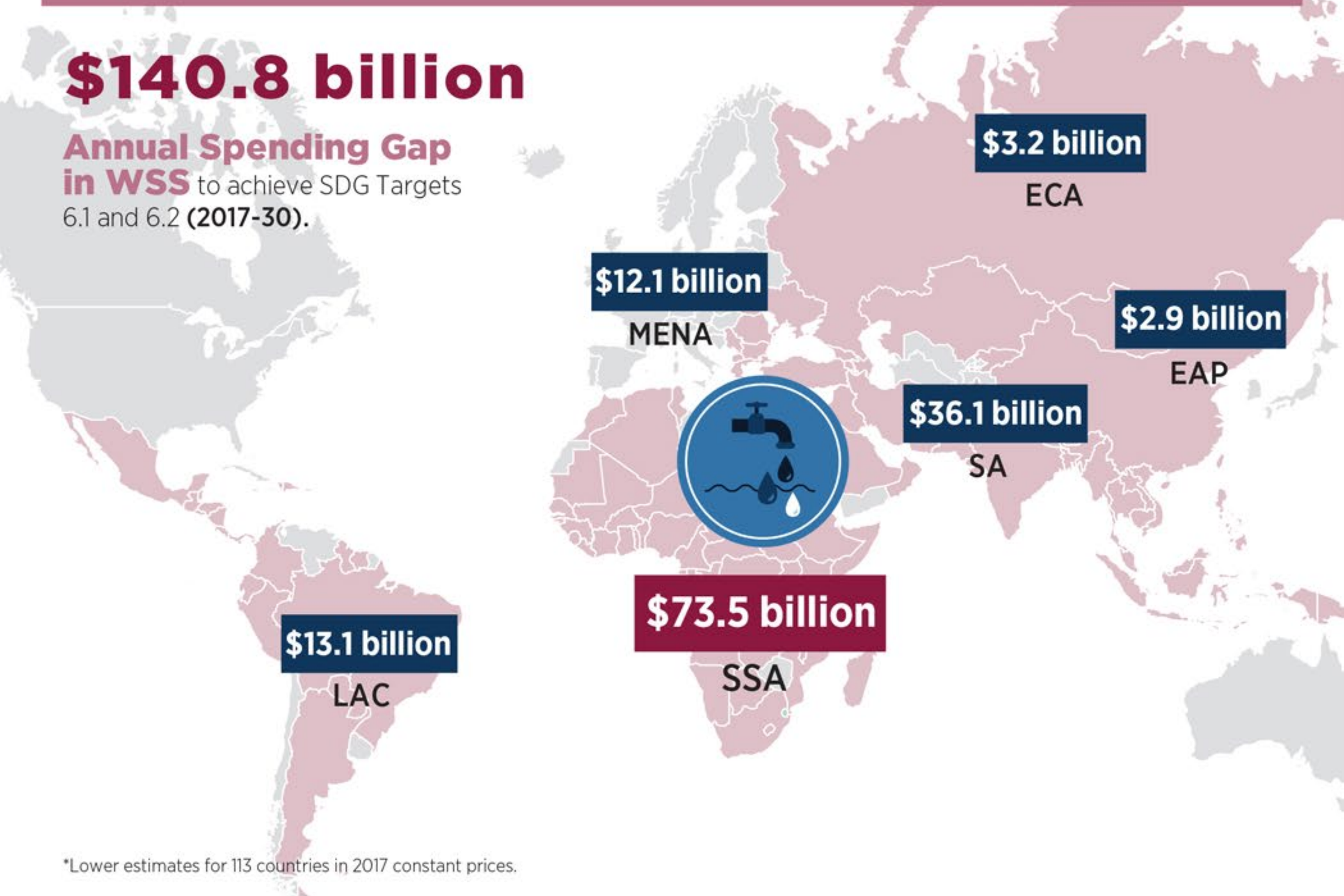
INFRASTRUCTURE INVESTMENTS IN WSS (2017)



Annual infrastructure investments in **WSS** are around **$ 20 billion** in 2017. The private sector only contributed about 9%.

CHALLENGES

SIGNIFICANT SPENDING GAPS TO ACHIEVE SDGs 6.1 & 6.2

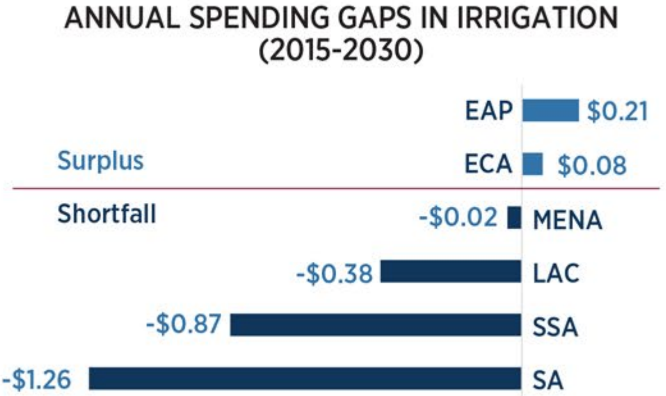


*Lower estimates for 113 countries in 2017 constant prices.

SMALLER BUT NOTABLE SPENDING GAP IN IRRIGATION

$3.5 billion

Annual Spending Gap in Irrigation to subsidize irrigation infrastructures* **(2015-30).**



*Low cost estimates includes subsidizing irrigation infrastructures and promoting a low-meat diet for 41 countries in 2017 constant prices.

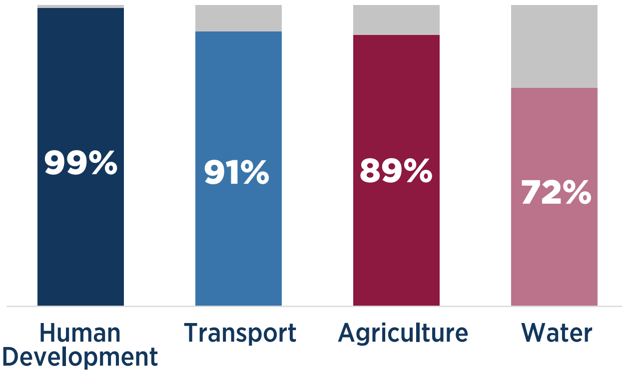
BUDGET EXECUTION IN WATER IS LOW

In the water sector, over one-fourth of funds were not used

72%

Average budget execution rate in the water sector between 2009-20.

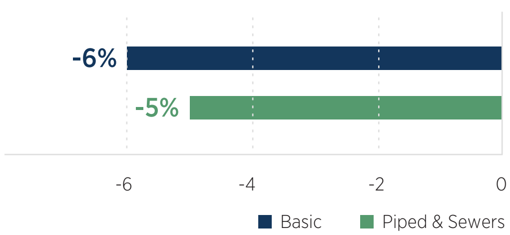
AVERAGE BUDGET EXECUTION RATES BY SECTORS (2009-20)



*Based on available budget data for 65 countries.

POOR PRODUCTIVITY AND EFFICIENCY

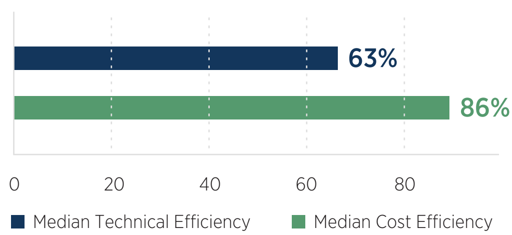
TOTAL FACTOR PRODUCTIVITY (2009-20)



5-6% ▼ For access to WASH, **total factor productivity** of public spending in the sector **declined** during 2009-20.

*Estimates for 58 countries.

TECHNICAL AND COST EFFICIENCY (2004-17)



The median **technical (production)** and **cost efficiency** of water **utilities** between 2004-17 **show room for improvement.**

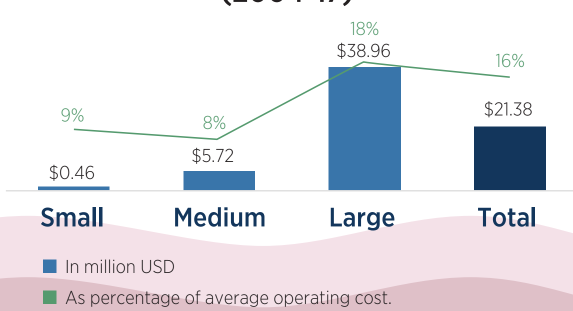
*Estimates for 1,599 water utilities from 68 countries.

HIDDEN LOSSES BY WATER UTILITIES

$21.38 million

is lost annually by a typical water utility due to cost inefficiencies

AVERAGE MONETARY VALUE OF EFFICIENCY LOSS (2004-17)

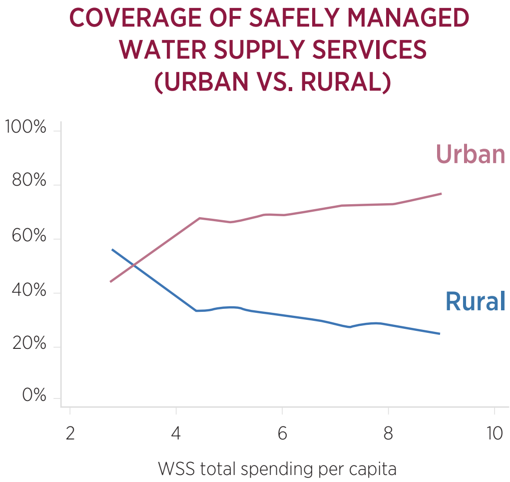


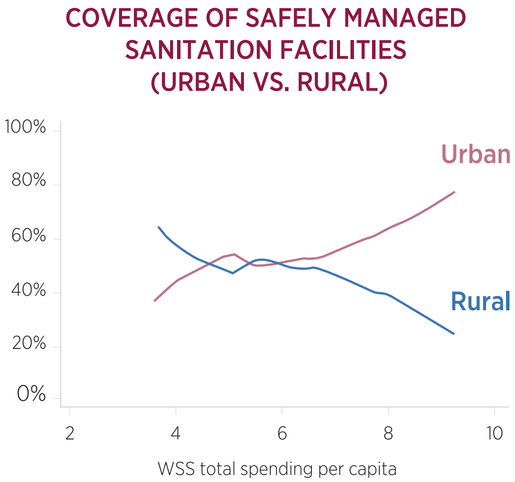
*Estimates for 1,557 water utilities from 67 countries in 2015 constant prices. Size of water utilities are defined by the terciles of population served.

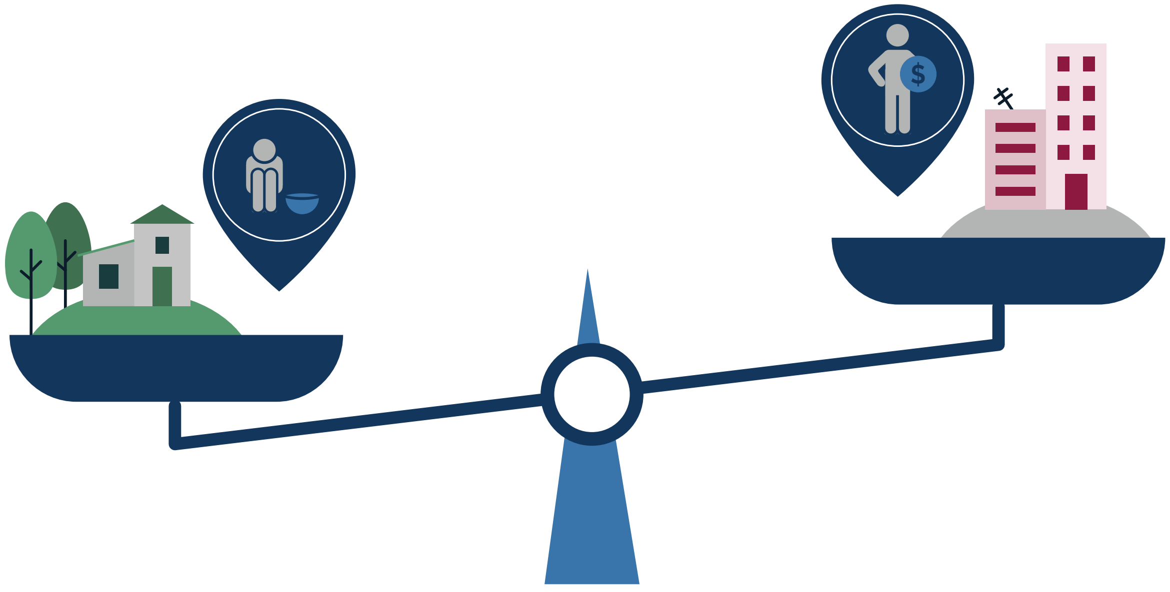
Public Spending on WSS Often Benefits Wealthier and Urban Communities Disproportionately

Subsides in the water sector tend to be regressive because the benefits only **accrue to those with access.**

The degree of **regressivity** is most **pronounced** in **Sub-Saharan Africa.**







POLICY RECOMMENDATIONS

IMPROVING WATER SECTOR SPENDING

Improving utilization and efficiency

- Improve Public Investment Management (PIM) to enable smoother and faster project implementation and to enhance absorptive capacity of the sector.
- Reform Public Financial Management (PFM) to enable predictable, timely and transparent flow of funds.
- Develop a realistic metric of the performance of public entities and SOEs, to balance the tradeoff between equity and efficiency.

Catalyzing the flow of long-term financing

- Develop a credible regulatory system for risk pooling and long-term financing.
- Create special purpose financial institutions to channel long-term finances into the water sector.
- Dedicate public and donor funds as guarantees to reduce risks associated with investments in the sector.

Reforming the water sector

- Cost recovery and demand management, through a combination of pricing and behavior change initiatives.
- Improve state capacity and the capacity of human resources to enhance absorptive capacity of the water sector.
- Improve data access, transparency, and communication to improve accountability in service delivery in the water sector.

Executive Summary

Introduction

THE WATER CRISIS

Water is the basis of all life on our planet. Since ancient times, the prosperity, sustainability, and wellbeing of all living populations have been determined to a large extent by the availability of water. Today, water remains at the heart of social life and economic progress. It plays a central role in both the society and the economy—by facilitating economic growth and human capital development, and by creating new possibilities for individuals and groups, possibilities that have the power to reduce poverty for current and future generations and improve the quality of people's lives. There is therefore an urgent need to give clearer recognition to the role of water as a connector that spans essentially all economic activities—from energy generation, transport, and food production to education, sanitation, public health, and the reduction of the global burden of disease. In addition to Sustainable Development Goal (SDG) 6—the target that relates directly to water—the attainment of most of the other sixteen United Nations SDGs is also conditioned, directly or indirectly, on the availability of water.

Still not on track. Despite this, nine years into the SDG era, the world is still not on track to achieve its goals for water. Budgetary spending data on water supply and sanitation (WSS) from the BOOST database and several others, together with the data on spending requirements to achieve safe affordable drinking water for all (SDG target 6.1) and the eradication of open defecation and universal access to safely managed sanitation and hygiene (target 6.2) (Hutton and Varughese 2020), reveal that most countries are not spending enough to achieve these two vital targets by 2030. In fact, to achieve universal coverage for safely managed drinking water and sanitation by 2030, it would require at least a quadrupling of current rates of progress (WHO and UNICEF 2021, 2023).[1] Yet this task may be even harder now than in the past, for two reasons. First, substantial resource constraints, both natural and financial underlie the twin challenges of broadening access and of improving service quality that the water sector faces. Second, the goals the world set in 2021 at the UN Climate Change Conference COP26[2] in response to climate change require greater government investments to achieve the targeted levels of adaptation and mitigation in the water sector.

In addition, because investments in irrigation and other complementary agricultural support activities have not kept pace with population growth, achieving SDG 2 (Zero Hunger) is also proving difficult. Between 2014 and 2019, virtually no region in the world lowered its hunger and undernourishment rates (FAO et al. 2021; FSIN and Global Network Against Food Crises 2023). Rather, food availability per capita has declined, and vulnerability to food insecurity has increased in many developing countries (FAO et al. 2021; FSIN and Global Network Against Food Crises 2023). Higher investments in irrigation along with complementary agricultural support measures will be needed to bridge these gaps.

Additional pressures on the spending gap. Yet just when there is a need for more money, there is less money available than ever. Ongoing recessionary tensions throughout the global economy, coupled with pandemic, conflicts and natural disasters, have placed additional pressure on governments' limited fiscal space (Augustin et al. 2022; Kose et al. 2021). These developments, taken together, make the challenge of bridging the water sector's financing and funding gap more pressing yet at the same time more difficult to achieve. In light of the ambitious goals set by governments and international agencies for the sector, the water sector's overarching policy imperative at the moment is to find a way to bridge this spending gap in the near to medium term.

An information deficit. A significant obstacle to achieving these goals, however, is the need to generate comprehensive, accurate, current, and detailed information on how much, and how well, financial resources are being spent in the sector at the national, regional, and global levels.

THE CURRENT STUDY

This study is a first-ever attempt to gain a 360° panoramic view of spending in the entire global water sector to better understand the financing and funding gaps in relation to sector goals, and consequently guide thinking on alternative ways to close them. It estimates total water expenditure at various levels of disaggregation, and at the global and regional scales, using several data sources, including budget data and national accounts data, and the updated versions of all available databases on infrastructure spending from various sources, including private and foreign funding.

The study thereby presents an integrated assessment of global and regional public spending in the water sector and its main subsectors. It presents findings that seek to answer questions about how public funds are spent in the sector, how well they are spent, and the financing and funding gaps[3] in the sector to help the government meet sector goals. The study is intended as a guide that governments and a range of other stakeholders can use to improve decision-making and thereby facilitate reforms to increase financing and funding in the water sector, enhance the utilization of already allocated funds, and raise the efficiency with which existing resources are employed to maximize development impact.

KEY FINDINGS

Spending gaps in WSS and irrigation. The study's findings demonstrate what many have long suspected but now have empirical evidence for—that two of the main subsectors, the water supply and sanitation subsector (WSS) and the irrigation subsector, face significant spending gaps to achieve their respective targets (part 2 chapter 2).

For instance, to achieve SDG targets 6.1 and 6.2 the WSS subsector faces an annual spending gap of between $131.4 billion and $140.8 billion in 2017 prices. The irrigation subsector has a spending gap of $3.5 billion a year even in a low-cost spending scenario that involves subsidizing irrigation infrastructure only and reducing agricultural demand.

The primacy of the public sector. Where will the needed financing come from? The public sector—the government and state-owned enterprises (SOEs)—remains the primary source of both financing and funding for the water sector. About 91.4 percent of total spending in the sector comes from the public sector (part 3 chapter 1). Over the last decade, private sector investments have been relatively marginal—only 1.7 percent of the total annual spending in the water sector (part 3 chapter 1). That apportioning of financing/funding responsibilities is not likely to change soon.

Poor budget execution rates. Given the fiscal challenges countries currently face, stepping up public financing will not be easy, but the other side of the matter is that water sectors in most countries, believe it or not, are not fully spending the budget allocations made to them at the start of the fiscal year. The sector's budget execution rates average about 72 percent during 2009-20, meaning that some 28 percent of allocated funds go unspent (part 3 chapter 2). Low budget execution rates point to systemic constraints on the sector's absorptive capacity, which in turn is anchored in a range of institutional, governance, project management, and political economy factors. Higher execution rates, by themselves, would narrow the water sector's enormous financing gap with lesser need for greater financial outlays.

Declining productivity and efficiency. Another avenue for bridging the sector's spending gap is to improve the productivity of public spending and reduce the inefficiencies of water service providers (part 3 chapter 3). Over the ten-year span- from 2009 to 2020—and indeed longer—water sector public spending has faced declining total factor productivity (5–6 percent) mainly because of efficiency losses. Only 35 percent of the utilities in the International Benchmarking Network (IBNET) database fully cover their operations and maintenance (O&M) costs of service provision and an even smaller share, 14 percent of all utilities, cover their total full financial cost—that is, O&M plus future capital costs. Moreover, based on data from 1557 water utilities from 67 countries, between 2004 and 2017, the average efficiency losses incurred by a typical water utility averaged approximately $21.4 million a year in 2015 prices, about 16 percent of the average total operating costs of these utilities. Improving productivity and efficiency in the water sector is an imperative which requires drastic changes across the spectrum, ranging from improving engineering designs to enhancing the motivation of the labor force.

The equity challenges. Finally, attracting more funds into the sector, as vital as this is, needs to be coupled with a commitment to spending those funds equitably (part 3 chapter 4). Water supply and sanitation and irrigation services are marked by significant subsidies from the government which need to be targeted smartly to benefit the disadvantaged communities, including those who live in difficult-to-reach areas such as dense urban districts and remote rural regions. Analysis of public spending in the provision of WASH services in several countries clearly demonstrate a bias towards the non-poor segments and urban populations. This means that, given the presence of high levels of subsidies in the provision of WSS services, public money is targeted more towards the less deserving segments of the society. These biases in targeting needs to be carefully addressed as the countries move towards universal access to safe water supply and sanitation services.

WHAT IS UNIQUE ABOUT THE WATER SECTOR?

Water has certain unique public values and other attributes that give governments a dominant role in the sector. These include the fact that water is a merit good, there are spillover effects from its use, and the capital intensity needed to offer water services favors a monopoly structure. In addition to these, there are equity issues, affordability concerns, and the difficulty of defining property rights—three factors that discourage private sector participation. Additionally, as an exhaustible yet common-pool resource, water's long-term availability cannot be taken for granted. Indeed, in the absence of well-defined property rights, competing uses could lead to overexploitation, depletion, and/or pollution. Several of these attributes are briefly discussed below.

Services such as water supply and sanitation are merit goods; this means that the society values everyone having access to such services rather than not having them. For a well-functioning modern society, certain services and assets are considered prerequisites- public health, public transport, education, renewable energy, and open green spaces are so fantastic that as many people as possible should be consuming as much of them as possible. The government, which in principle, has an interest in creating socially desirable outcomes is the perfect candidate for producing and offering merit goods to the public.

Further, services such as water supply, sanitation, and irrigation tend to generate positive externalities meaning that when consumed they generate positive spillover effects that benefit the public generally, not just the individuals who pay for the service. For example, public health benefits of the provision of water supply and sanitation services have long been established. This makes it appropriate for government to subsidize the cost of water services because more people benefit than just the paying users. In fact, the price the actual consumers would be willing to pay for WSS services would reflect only the benefits they themselves are privately getting from it, while the rest of the public gets to enjoy the benefits of public health for free. Therefore, the private sector will be less willing to provide such services where the market price reflects the much lower private benefit and not the higher social benefit. A free-market economy would therefore underprice, undervalue, and hence under-produce and under-consume such services which generate positive externalities.

A capital-intensive sector with monopoly characteristics. Water sector infrastructure and services are highly capital-intensive, with high fixed capital costs and long payback periods. Once the infrastructure is set up, the marginal cost of providing service to an additional user is minimal. The high costs are all upfront. This impedes competition because it is economically unviable for a newly entering competitor to duplicate such infrastructure due to the high initial costs. And it is not desirable from a social welfare perspective to promote competition in such case due to the loss of economies of scale and scope.

Equity concerns. For the same reason, private service providers are reluctant, for fear of losses, to set water tariffs at less than the full cost-recovery price. Yet in practice, water tariffs are in fact often set well below cost recovery levels because otherwise many people cannot afford the services. In practice, then, especially in countries where broad inclusion has become a political goal, the government steps in and subsidizes the service provider to balance the business need for commercial viability and the sociopolitical need for inclusion.

Poorly defined property rights and common pool characteristics. Another complication that inhibits the engagement of service providers in the water sector involves the securing of property rights, a complicated process often linked to the nature of water that flows across space. In most countries, even the most advanced, WSS providers are typically state-owned, and water resources are held as national or common property or owned by public institutions. This means private firms entering the sector to build infrastructure or provide services must negotiate with state agencies over production volumes, tariff rates, service prices, and regulations—which compromises the business models most private firms would prefer to use. Further, the relative absence of clear property rights, coupled with the common-pool nature of water, makes it difficult to exclude others from using the available water. This has led to the phenomenon called "the tragedy of the commons"—the unchecked overuse of a finite, valuable, nonrenewable resource by consumers who have unimpeded access to it, each acting only in their own self-interest. An example of this is Western India's rapidly depleting groundwater tables (Ostrom [1969] 1999).

These varied circumstances, all linked to distinctly unique water sector attributes, all require government intervention not only to set the rules of the game but to take the leadership role in providing financing and funding. In short, free market conditions—the competitive determination of prices and the market-led allocation of resources through voluntary exchanges among numerous buyers and sellers—do not exist in this sector. This is both caused by, and leads to, government's central role in regulating, operating, and pricing water sector services.

The necessary involvement of government, however, also increases the sector's vulnerability to the characteristic shortcomings that public sector activities and arrangements have traditionally been fraught with, including institutional fragmentation, widespread inefficiencies and policy distortions of various types.

HOW MUCH IS SPENT ON WATER?

Institutional fragmentation. In many countries, the fragmentation of institutions has thwarted an integrated approach to water resource management. In most country settings, water resources are allocated, managed, and regulated by an entire phalanx of state entities that speak past each other, each with its own set of policies, priorities, perspectives, and budget, and with limited communication among them. The result: the absence of a clear and coherent investment roadmap for the sector.

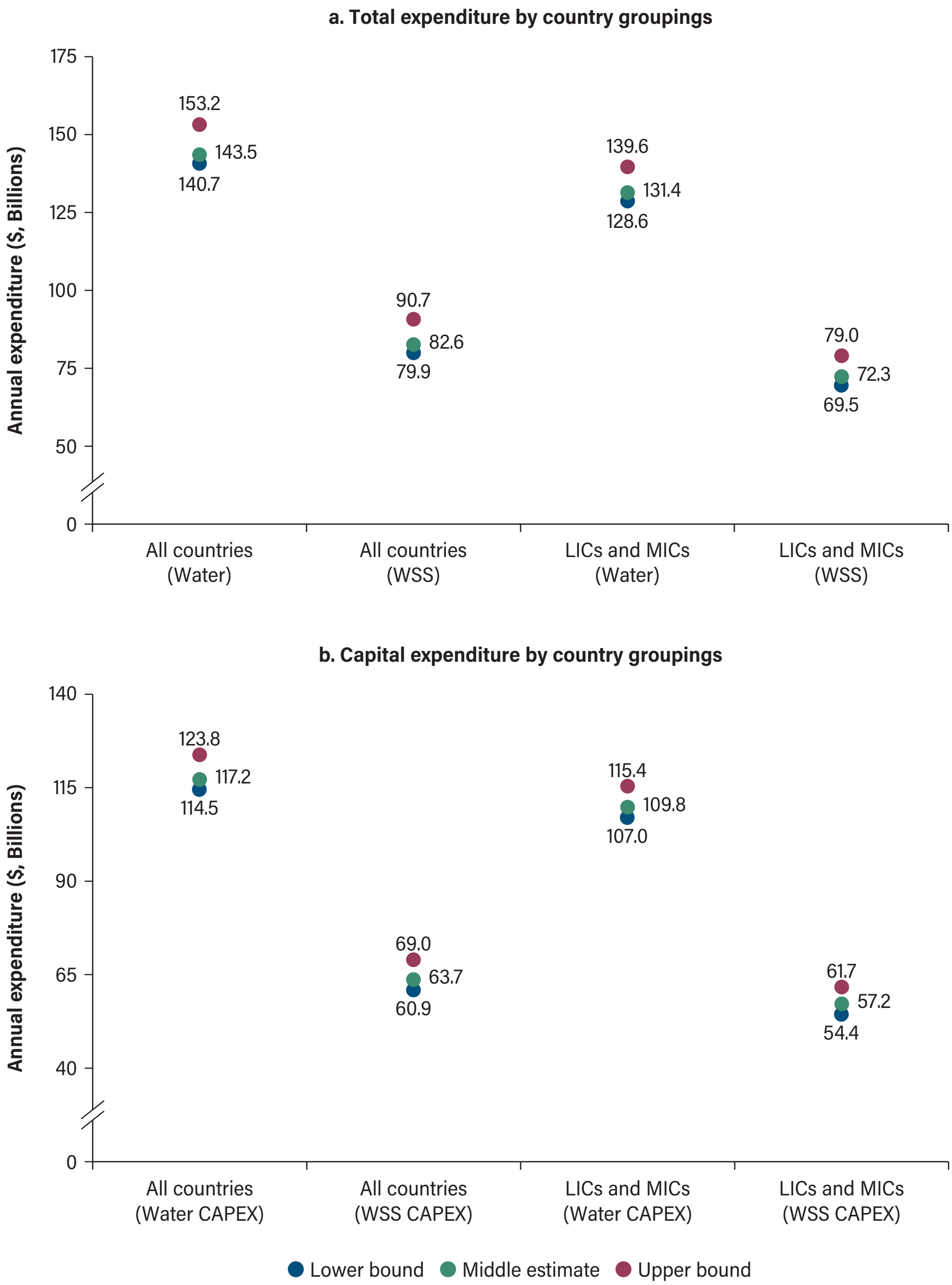
Developing an integrated comprehensive account of the actual levels of water sector spending is essential for policymakers to (i) prioritize spending needs, (ii) gain a holistic picture of the spending required to achieve sector-related SDG goals—and hence the spending shortfall—and (iii) explore potential synergies and tradeoffs among water subsectors. Previous spending estimations in the sector have offered an oversimplified account of the infrastructure spending shortfall.

Estimated annual total spending in the water sector. This study, for the first time, offers an accurate estimate of water sector public spending that encompasses four subsectors—WSS, irrigation, water transport, and hydropower. For the 130 countries included, total annual public spending in the water sector is estimated at $140.7 billion in 2017 prices. This corresponds to a lower bound (figure ES.1). If the private sector is included—a middle estimate—total spending is, then, $143.5 billion. Finally, if state-owned enterprises (SOEs) are also included—the upper bound—annual water sector spending becomes $153.2 billion in 2017 prices. These estimates correspond to approximately 0.45 percent, 0.46 percent, and 0.49 percent of overall GDP, respectively (figure ES.2). These figures cover domestic spending in the water sector and did not include official development assistance (ODA) to avoid potential double counting during the estimations. If ODA is added, annual total spending in the water sector would come to $164.6 (see sections below, figure ES.5). More than half of total water sector spending is in the WSS subsector, estimated to be between $79.9 billion (lower bound) and $90.7 billion (upper bound), or between 0.25 percent and 0.29 percent of overall GDP, with a middle estimate of roughly $82.6 billion, or 0.26 percent of GDP. Regionally, in both the water sector and WSS subsector, East Asia and Pacific (EAP) (including China) comes in as the highest spender, both as a share of its regional GDP and in absolute terms.

The capital-intensive nature of water sector spending. Spending in the water sector is, not surprisingly, capital-intensive. Annual capital expenditure (CAPEX) accounts for about two-third of the total expenditure, ranging between $114.5 billion (0.36 percent of the overall GDP) and $123.8 billion (0.39 percent of the overall GDP). Meanwhile, annual capital spending for WSS is estimated to be between $60.9 billion (0.19 percent) and $69.0 billion (0.22 percent).

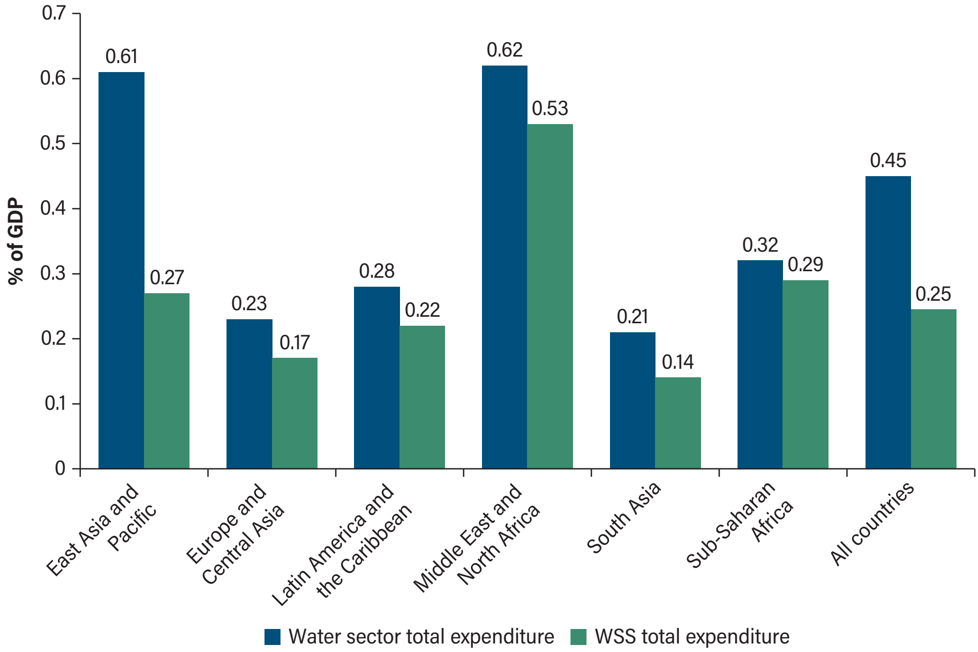
Low spending by FCV countries. On the other hand, fragile and conflict-affected countries (FCV) spend only between $2.8 billion (0.2 percent) and $3.9 billion (0.34 percent) annually on the water sector, of which $2.2 billion (0.19 percent) to $3.1 billion (0.27 percent) is capital expenditure (CAPEX). These estimates further underscore the distinct financing and funding challenges faced by FCVs in developing the infrastructure of their water sector.

FIGURE ES.1 Estimated Annual Expenditure in Water Sector and WSS (2017 constant prices)



Source: Authors' estimation using BOOST and other databases.
Note: Official development assistance is not included. 130 countries are included, of which, 115 are low-income countries (LICs) and middle-income countries (MICs). CAPEX = capital expenditure; WSS = water supply and sanitation.

FIGURE ES.2 Estimated Annual Spending in Water Sector and WSS as a Share of GDP (lower bound), by Region



Source: Authors' estimation using BOOST and other databases.
Note: Official development assistance is not included.

Government dominates spending. Public spending by government entities through the budget, amounting to $140.7 billion a year (lower bound), makes up most of the annual spending in the water sector.

Development outcomes beyond SDG 6. Finally, beyond SDG 6, water sector spending can significantly impact a range of other development outcomes. In particular, it can contribute to SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Wellbeing), and SDG 5 (Gender Equality). Higher water sector per capita spending correlates with a lower prevalence of poverty and stunting among children and higher human development outcomes, even when country income categories are accounted for. By recognizing how water interconnects with other important development outcomes, policymakers can not only better justify water sector budget allocations but also pursue a more comprehensive approach to water resource management that yields far-ranging socioeconomic benefits.

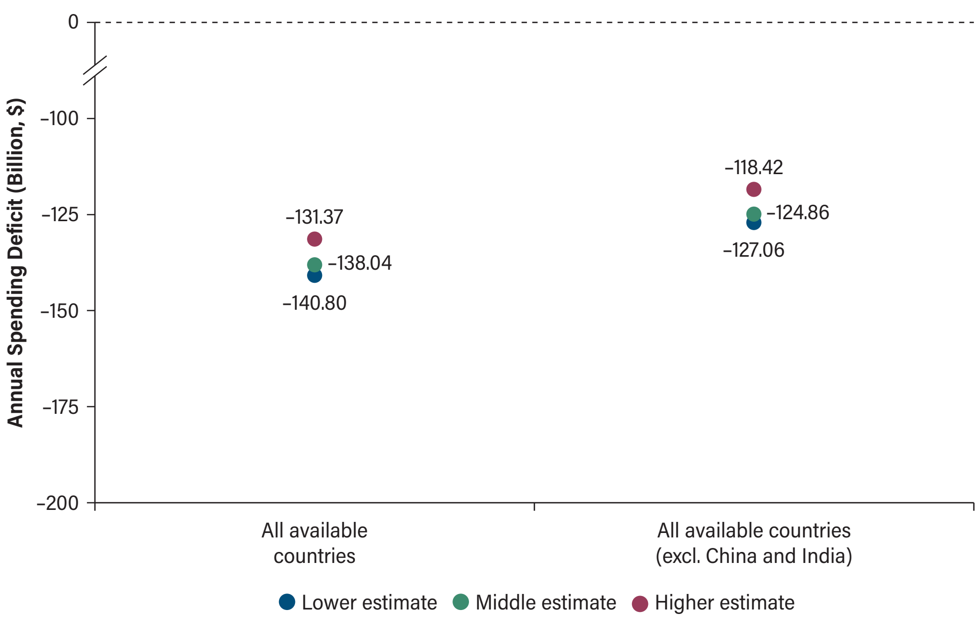
HOW BIG ARE THE WSS AND IRRIGATION SPENDING GAPS?

To the best of our knowledge, no previous studies have succeeded in producing reliable estimates of the spending gaps in WSS and irrigation because of the dearth of comprehensive national spending information from budgetary sources.

Spending gaps in WSS. Due to a shortfall in actual spending when compared to the required levels, many countries are falling short of achieving the SDG targets for universal access to safely managed water supply and sanitation by 2030. The estimated annual spending gap between 2017 and 2030 to achieve these targets ranges from $131.4 billion to $140.8 billion, with a middle estimate of $138.0 billion (figure ES.3). These figures represent between 0.45 percent and 0.48 percent of the 113 countries' overall GDP. On average, countries will need to increase annual spending to between 2.7 and 3.0 times the current level to bridge this spending gap to meet the SDG targets by 2030. Among the regions, SSA have the largest annual spending gap to achieve this target, followed by SA and MENA. The annual spending gap for SSA to meet SDGs 6.1 and 6.2 is estimated to be between $69.85 billion (4.35 percent) and $73.48 billion (4.58 percent) (figure ES.4). For SA, the corresponding estimates are $35.99 billion (1.08 percent) and $36.11 billion (1.08 percent). To bridge this gap, current annual spending would need to increase to between 9.5 and 17.0 times its current level for SSA, followed by SA, between 8.5 and 8.8 times.

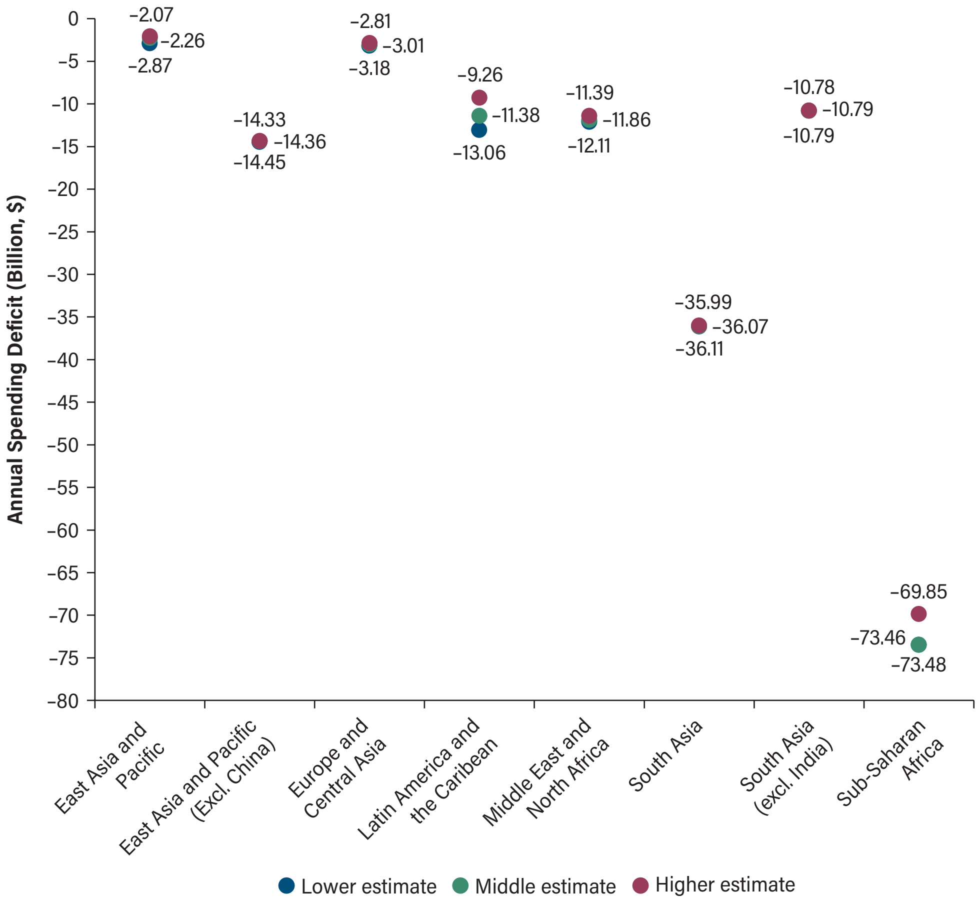
Larger spending gaps among FCVs and LICs. However, the challenge to meet the SDG targets for universal safely managed WASH services is even bigger for the FCVs and low-income countries (LICs). The annual spending gaps to achieve these targets are estimated to be between 4.71 and 4.80 percent of GDP for FCVs, and even

FIGURE ES.3 Average Annual Spending Gaps to Achieve SDG Targets 6.1 and 6.2, All Countries (2017 constant prices)



Source: Authors' estimation using data from Hutton and Varughese (2020) and the BOOST, and other databases
Note: Official development assistance is not included.

FIGURE ES.4 Average Annual Spending Gaps to Achieve SDG Targets 6.1 and 6.2, by Region (2017 prices)



Source: Authors' estimation using data from Hutton and Varughese (2020) and the BOOST, and other databases.
Note: Official development assistance is not included.

higher—between 9.16 percent and 9.34 percent of GDP—for LICs. To bridge these financing gaps, FCVs will need to increase their current annual spending to roughly 19.0 to 28.5 times their current levels, and LICs between 23.7 and 42.3 times. Those are clearly stratospheric goals.

Achieving universal access to basic WASH services is more realistic. Although the substantial spending gap to achieve SDG 6.1 and 6.2 by 2030 underscores an urgent need for action, current rates of progress suggest that many countries may not be anywhere close to attaining these targets by 2030. For many, a more realistic target would be achieving universal access to *basic* water, sanitation, and hygiene (WASH) services by 2030. Overall, most countries are spending enough on an annual basis (between 2017 and 2030) to achieve universal access to basic WASH services by 2030. Indeed, it is estimated that, currently, the countries collectively have an annual surplus of between $12.9 billion (0.04 percent of total GDP) and $22.3 billion (0.08 percent of total GDP) in 2017 prices, with a middle estimate of about $15.6 billion, or 0.05 percent of the GDP. However, it must be noted that the averages often mask significant country level differences in spending needs.

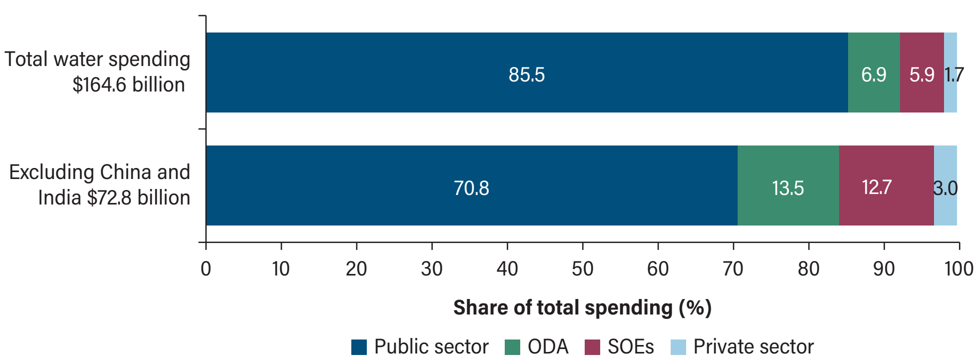
Spending gaps in irrigation. The irrigation subsector spending gap is less daunting but still grim. Our analysis of 41 countries indicates that, on average, they are not spending enough to achieve even the low-cost target by 2030 (Rozenberg and Fay 2019).[4] Together, they maintain an annual spending shortfall of $3.5 billion between 2015 and 2030—about 0.07 percent of their 2017 GDP.

Underestimations. Keep in mind that these spending gaps are likely to be underestimations. For one, climate change effects—including water stress, water scarcity, and infrastructure damage by floods and the like—are expected to aggravate the costs of providing sustainable levels of WASH and irrigation services. In the coming decades, as many as 33 countries, many of which currently have WSS spending shortfalls, could experience extremely high levels of water stress (Luo et al. 2015).

WHAT ARE THE SOURCES AND FEATURES OF WATER SECTOR SPENDING?

The four main sources of water sector spending are (i) government budgetary allocations, (ii) public spending through SOEs, (iii) ODA, and (iv) the private sector. Estimated total spending in 2017 was $164.6 billion.[5] As shown in figure ES.5, public sector spending (by public entities and SOEs) made up almost 91.4 percent of total spending (about $150.5 billion), followed by ODA[6]

FIGURE ES.5 Share of Water Sector Spending, by Source (2017 prices)



Source: Authors' estimation using BOOST and other databases.
Note: (1) Public spending and SOE spending are calculated based on part 2 chapter 1; (2) Private sector annual average spending from 2008 to 2017 was calculated from the SPI-PPI database; (3) ODA here includes other official flows (OOF). ODA in 2019 to all developing countries was about $192.2 billion (current $) and OOF was $68.8 billion.

(6.9 percent, $11.3 billion) and the private sector (1.7 percent, $2.8 billion).[7] Fiscal spending (by national, federal, and local governments) alone constituted 85.5 percent (about $140.7 billion).

Water sector spending as a share of government spending. In relative terms, governments really do not spend much on their water sectors. To put this in perspective, for the 68 countries for which data are available, average government spending in the water sector through the budget between 2009 and 2020 constituted only about 1.2 percent of total government spending. A large part of government spending was absorbed by the transport, energy, and human development sectors.[8] For example, the human development sector alone drew in more than 60 percent of government spending during the period.

Other notable features of water sector spending:

Capital intensive. Capital spending constituted almost two-thirds of total public spending in water (the remainder being recurrent spending). However, in the water sector, the share of capital spending fell from 71.6 percent in 2009 to about 56.8 percent by 2020. This may indicate declining infrastructure development in the sector, which would be disconcerting considering the large spending gaps to achieve the sector's SDG targets.

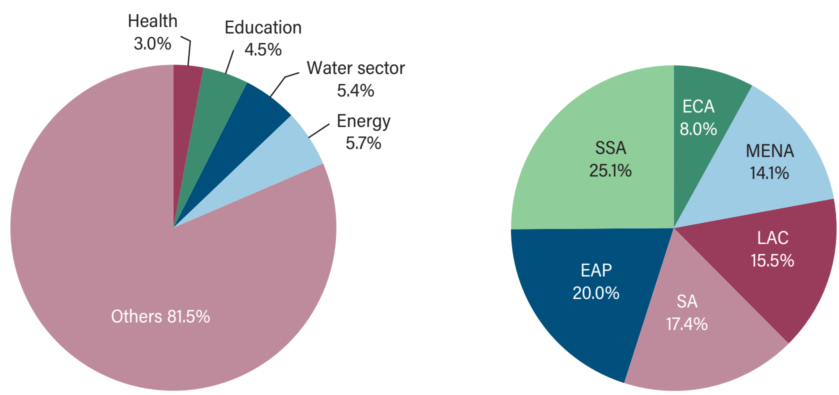
Low maintenance spending. It is equally troubling that maintenance spending in all the water subsectors—WSS, water transport, and irrigation—has been so modest. Regular maintenance is crucial to sustaining the functioning of physical infrastructure and can generate substantial savings by extending its life cycle (Rozenberg and Fay, 2019).

Low ODA inflows into the water sector. Between 2011 and 2019, the water sector attracts only 5.4 percent of ODA worldwide (figure ES.6), but ODA constitutes about 6.9 percent of water sector funding (figure ES.5). Sub-Saharan Africa (SSA) received the largest share of the total water sector ODA, at 25.1 percent. Meanwhile, the East Asia and Pacific (EAP) region also received a substantial proportion, accounting for 20.0 percent of the total water-related ODA during this period (figure ES.6).

The public sector and infrastructure investments in WSS. Patterns in project-level infrastructure investments, once again, affirm the public sector as the prime source of WSS infrastructure development investment. In 2017, 91 percent of investments ($18.4 billion) were from the public sector, just 9 percent ($1.8 billion) from the private sector. Within the public sector, almost 80 percent of WSS infrastructure investments came from the government, 11 percent from SOEs.

The limited role of the private sector in WSS. Data about infrastructure projects from the SPI-PPI database reinforce the above findings. Between 2009 and 2019, private sector investment projects made up only about 8 percent of the total number of infrastructure projects in WSS. In 2017, 9 percent ($1.8 billion) of all project-level infrastructure investments in WSS came from the private sector (figure ES.7). This is small compared to the 17 percent share of private sector investments in all project-level infrastructure investments, which include those of other sectors like energy, transport, municipal solid waste and ICT. Given that substantial private funds are available, this emphasizes the need to rethink the strategy for attracting more private finance into the WSS sector.

FIGURE ES.6 Distribution of ODA by Sector and by Region



Source: Authors' elaboration using Credit Reporting System.
Note: ODA = official development assistance; CRS = Credit Reporting System; EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa.

FIGURE ES.7 Relative Shares of SOEs, Public Entities, and PPPs in WSS Infrastructure Development in 2017, by Region

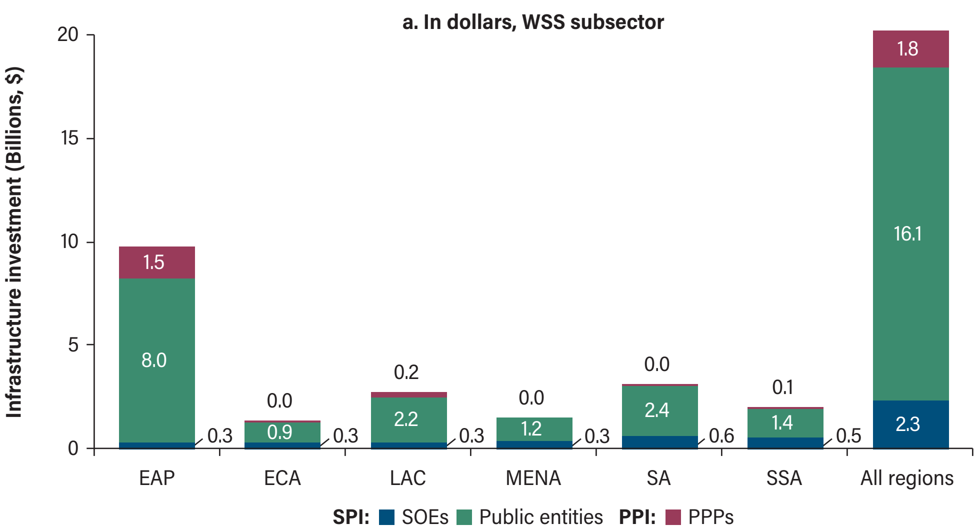


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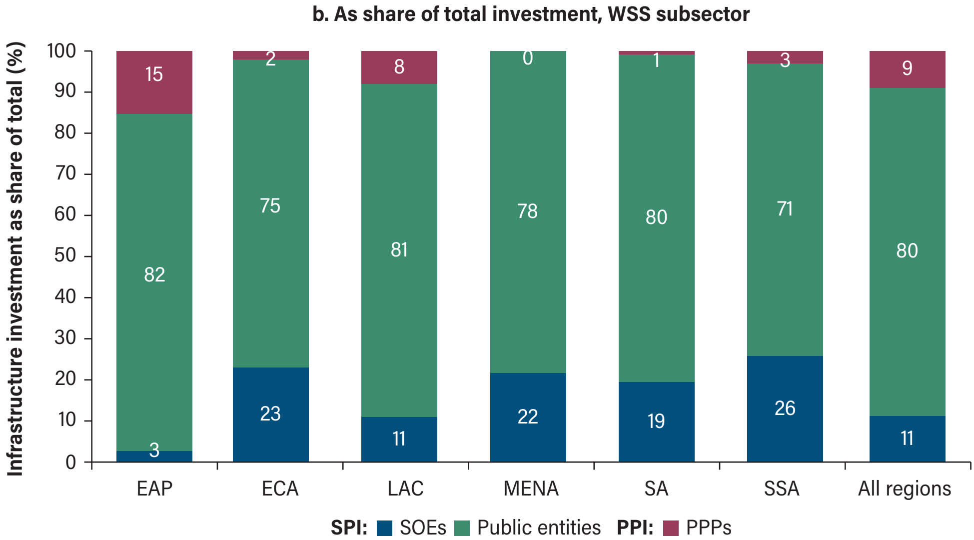
FIGURE ES.7 Relative Shares of SOEs, Public Entities, and PPPs in WSS Infrastructure Development in 2017, by Region (*Continued*)



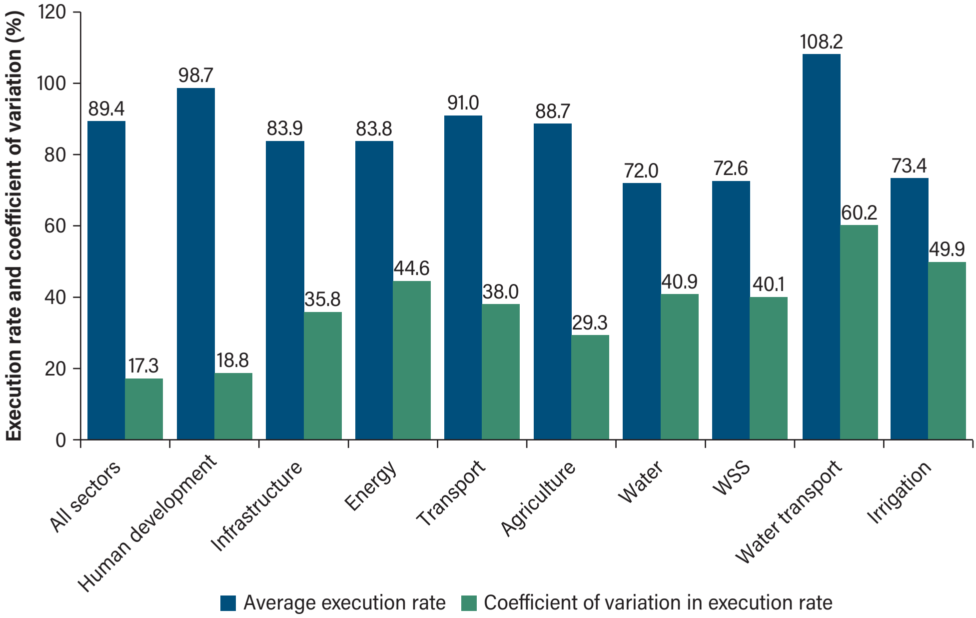
Source: Authors' estimation using PPI-SPI database; figures slightly different from SPI-PPI report due to correction of region misclassification.
Note: EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; PPI = private participation in infrastructure; PPP = public–private partnership; SA = South Asia; SOE = state-owned enterprise; SPI = SOE and other public sector-funded infrastructure; SSA = Sub-Saharan Africa; WSS = water supply and sanitation.

IS THE SECTOR SPENDING ALL AVAILABLE FUNDS?

Large spending gaps, poor budget execution. Considering the financing gap, it is a paradox that the water sector does not spend all the funding allocated to it. It primarily reflects two things—poor financial management and low absorptive capacity. During 2009–20, countries' budget execution rate averaged 72 percent—albeit with a high degree of year-to-year and country-to-country variation—meaning that about 28 percent of all budgeted funds went unused (figure ES.8). In comparison, the human development sector consistently has an execution rate of 99 percent, with relatively low variation. For the transport sector it is 91 percent, and for agriculture 89 percent.

Low absorptive capacity. What explains the sector's low absorptive capacity? Infrastructure projects take 6–15 years to complete, of which 3–8 years are spent on preparation and 3-7 years on implementation (IMF 2020). Budget preparation complications and delays in the implementing ministries and agencies can reduce the time for planning and implementation and result in cost overruns. And in infrastructure sectors where capital spending is predominant, such as water, spending especially depends on the speed of project implementation.[9]

FIGURE ES.8 Average Sectoral Budget Execution Rates and Degree of Variation

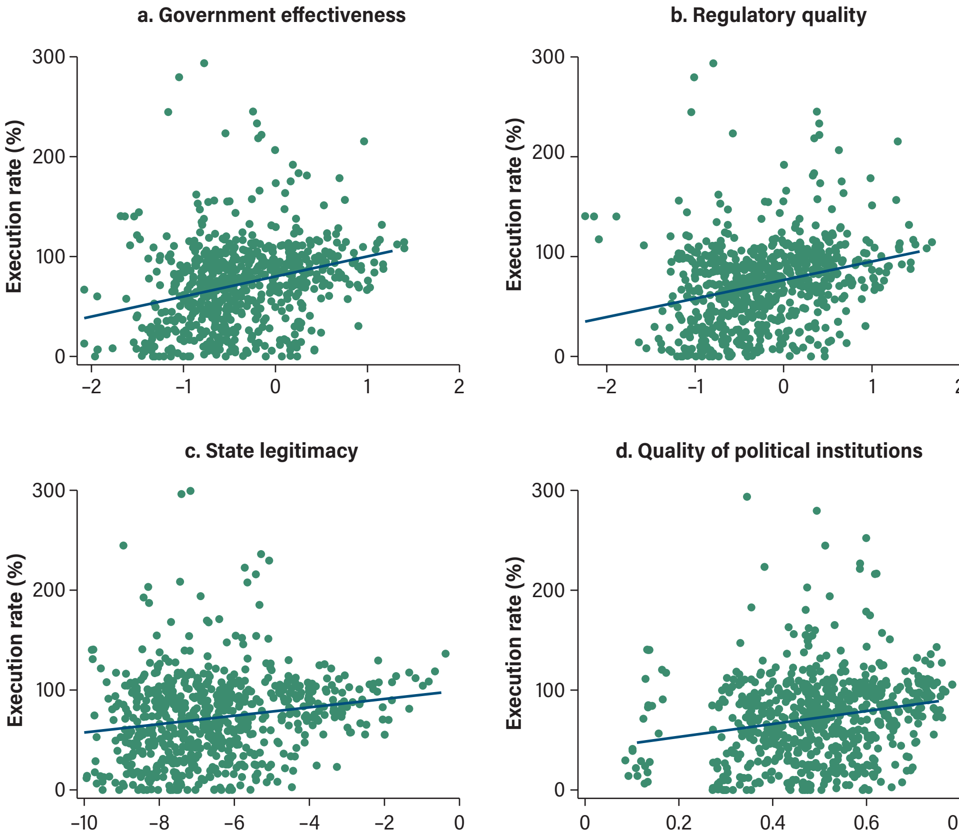


Source: Authors' elaboration using BOOST database.
Note: Average over years for each country provides assessment overall budget execution performance of countries. WSS = water supply and sanitation.

Improving budget execution rates can reduce spending gaps. A budget execution improvement corresponding to a reduction in the budget execution gap by 50 percent in the WSS subsector would raise the overall rate from an average of 73 percent to 87 percent, reflecting a 14-percentage point increase in budget utilization. This would translate into a significant reduction of the lower estimate of the annual global spending gap in WSS (to achieve SDG targets 6.1 and 6.2) from roughly $140.8 billion to $127.9 billion, corresponding to a $12.9 billion reduction in the spending gap for WSS.

Regulatory and institutional challenges. Low absorptive capacity also reflects systemic regulatory and institutional challenges that pervade the water sector. Political and institutional factors shape all aspects of planning and implementing infrastructure projects. Through econometric analyses, this study found that four indicators—governance effectiveness, regulatory quality, state legitimacy, and the performance of political institutions—are positively correlated with water sector budget execution rates (figure ES.9). Enhancing these measures of governance performance would help improve execution rates—as would addressing the fragmentation within water sector-related national agencies, having a coherent water policy, employing human capital effectively, ensuring accountability and transparency in the budgetary system, engaging in good project planning, and creating a sound institutional and political environment (Denizer et al. 2013; Isham and Kaufmann 1999). Countries with

FIGURE ES.9 Correlation between Water Sector Budget Execution Rates and Governance, Regulation, State Legitimacy, and Institutions



Source: Government effectiveness and regulatory quality data are from the Worldwide Governance Indicators (WBGI); State legitimacy data are from the Fragile State Index; performance quality of political institutions data are from Kuncic (2014)
Note: The x-axis in each plot represents standardized scores for governance indicators, which are coded in a positive direction.

better public investment management (PIM) and budget transparency usually have more success in implementing projects on time and on budget (IMF 2018).

DO INEFFICIENCIES GENERATE HIDDEN LOSSES IN THE SECTOR?

Thus far, the discussion about financing sources and budget execution has centered on how to raise the quantity (amount) of spending. By contrast, enhancements to total factor productivity (TFP) and efficiency improve the quality of how those funds are spent by broadening the population's access to good-quality, well managed water sector services. Both quantity and quality are crucial. With the world facing fiscal challenges from the pandemic, the Russia–Ukraine War, inflationary pressures, and the increasing incidence of natural disasters, getting a bigger "bang for the buck" from all available fiscal resources is a priority.

Using national-level budget data on spending in WSS service provisions, population access levels to WSS services from the WHO/UNICEF) Joint Monitoring Programme (JMP) for 130 countries, and IBNET data on 1,599 utilities from 67 countries over 14 years, the study raises and addresses several productivity- and efficiency-related questions: whether access levels are being attained efficiently—with the least possible cost—whether productivity can be improved within a given level of public spending in the provision of water supply and sanitation services, and whether there is room for water utilities to achieve efficiency improvements, especially as the world moves toward achieving the more ambitious (and more costly) targets envisioned under SDG 6.1 and 6.2.

Declining factor productivity. Between 2009 and 2020, the overall TFP of public spending on providing access to basic WASH services declined by about 6 percent, with significant country-to-country variation. What this means is that, for the same level of public spending as in 2009, output declined by 6 percent in 2020.

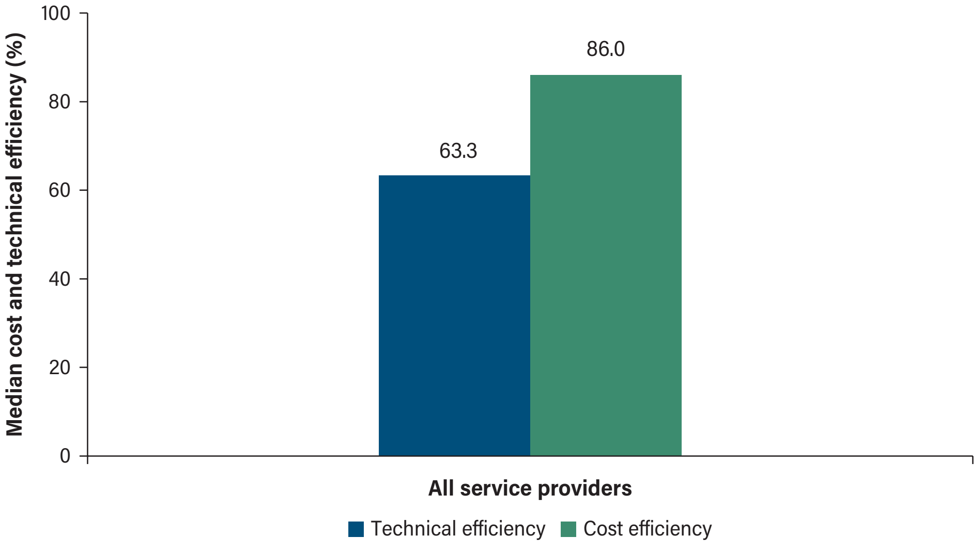
The TFP of public spending on the provision of access to higher-level WASH services (piped water, sewer connection) also declined overall, by about 5 percent. Average factor productivity decline was primarily driven by a decline in efficiency of 20 percent for basic WASH services as well as for higher-level, WASH services. Though technological change during the period, has the effect of raising TFP for both basic WASH services and higher-level WASH services, there is substantial room for efficiency improvements through better management and planning.

Inefficiencies among water utilities. From 2004 to 2017, the median cost efficiency of water utilities was 86 percent (Figure ES.10). This means that, compared to the best-performing water utility, the average water utility can cut its overall cost by 14 percent and provide the same level of service. Further, the median technical (or production) efficiency was only 63 percent, which means that, compared to the best-performing utility, the median utility could raise its output by 37 percent, given the same level of inputs. In short, from both the cost and the production perspectives, there is substantial room for efficiency improvements among water utilities.

Hidden losses due to inefficiencies. Finally, losses due to inefficiency can be thought of as hidden costs the water utilities are incurring. Globally, the value of the annual average efficiency loss per utility over the period of 2004–17 was $21.4 million in 2015 prices, which is an astounding 16 percent of the average annual total operating cost of all 1,557 utilities used for our analysis.

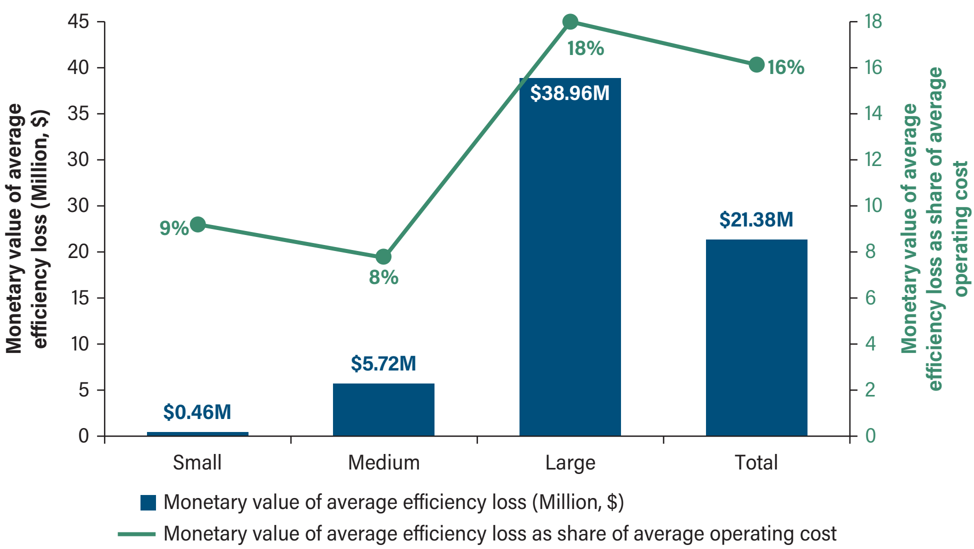
Figure ES.11 provides the monetary value of the average, cost-efficiency-related hidden loss (in $ million at 2015 prices) by utility size[10]. Small utilities had the lowest average efficiency loss, at $0.46 million in 2015 prices, but this constitutes a relatively smaller percentage of their average operating cost, at 9 percent. Medium-sized utilities had somewhat higher average efficiency losses—$5.72 million on average in 2015 prices—but this comprises a smaller proportion of their operating cost, at 8 percent. Large utilities, on the other hand, encountered the highest average efficiency loss—$38.96 billion on average in 2015 prices—corresponding to 18 percent of their average operating cost.

FIGURE ES.10 **Median Cost Efficiency and Technical Efficiency, All Service Providers, 2004–17**



Source: Authors' estimation using IBNET data.

FIGURE ES.11 **Monetary Value of Average Efficiency Loss as Share of Average Operating Cost, by Utility Size (2015 constant prices)**



Source: Authors' estimation using IBNET data.
Note: Instead of using deciles of population served, utilities are grouped into terciles—small, medium and large.

The efficiency of a water utility is also deeply influenced by its operational features and by the governance indicators and national demographic characteristics of its service area, such as population density. Regression results reveal that among country-level governance indicators, regulatory quality positively influences both cost and technical efficiencies. Additionally, regions with denser populations experience enhanced cost efficiency, likely because concentrated populations lead to lower per-capita water distribution costs. Understanding the relationships between a utility's operational features and broader national characteristics can guide targeted interventions to address specific ownership-based and size-based inefficiencies. Policymakers should prioritize sustainable water resource management to ensure cost-effective utility operations. Moreover, the pivotal role of design capacity on efficiency highlights the need for careful planning in determining investments in infrastructure development and technology upgrades.

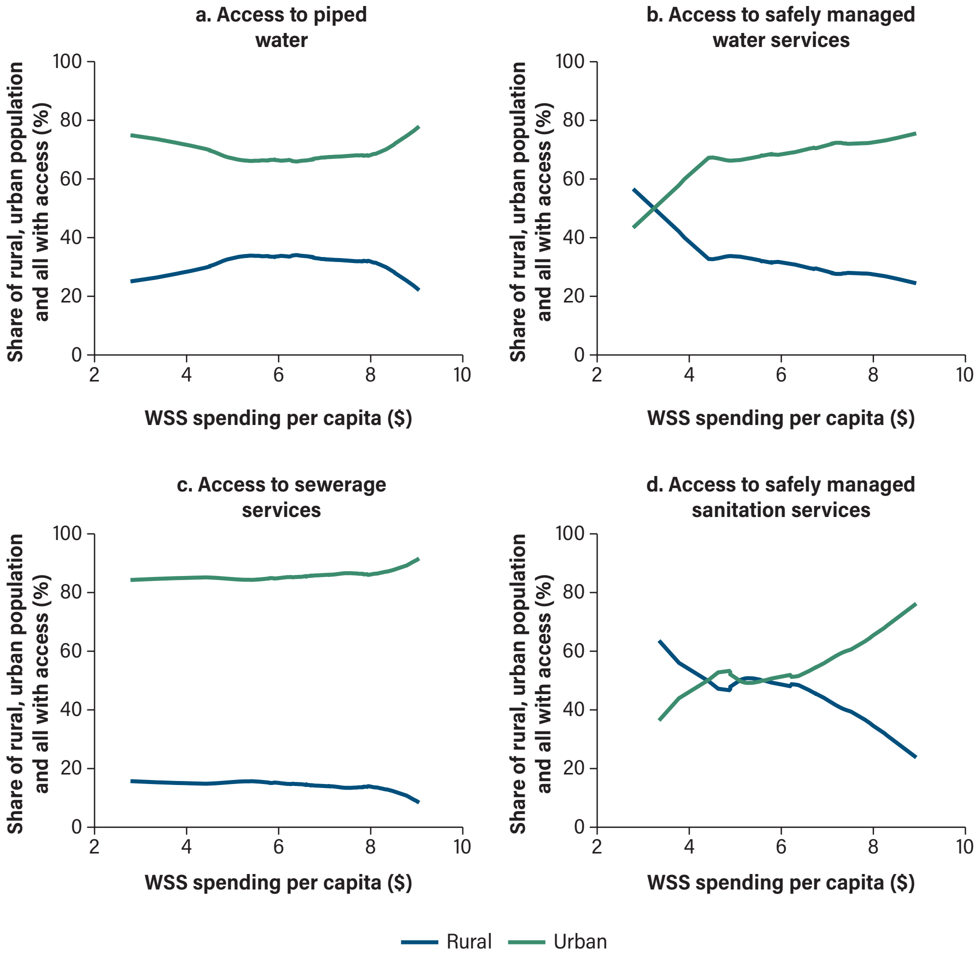
In summary, given the tight budgetary conditions, the potential for productivity and efficiency improvements is an area that the water sector should focus on. Such improvements achieved through systematic reform of water utilities can not only make additional resources available, but also can, catalyze the financial flows to the sector, particularly from the private sector.

WHO BENEFITS FROM WATER SECTOR SPENDING?

Equitable spending through targeted subsidies. The SDG targets emphasize economic as well as ethical importance of extending higher-level water sector services to underserved communities. Although attracting more funds into the sector is crucial, it is equally vital that this is coupled with a commitment to equitable spending. Poor access to WASH services, for example, compromises peoples' health, children's development, prospects, and safety, not to mention their privacy and dignity (WHO and UNICEF, 2021, 2023). Every year, a significant amount is being spent as consumption subsidies in the water sector, primarily, to address the affordability challenges faced by the poor. However, politically advantaged urban elites who could afford to pay fully for water services enjoy subsidies originally earmarked for the most vulnerable—creating errors of both inclusion and exclusion. It underscores the need to adopt smart targeting of water consumption subsidies as a way that addresses the disparities ingrained in the water sector, especially state capture by vested interests.

Errors of inclusion and exclusion. In the context of pervasive poverty and the exclusion of marginalized groups on ethnic, religious, and gender lines, market forces alone may not ensure equitable water services. Particularly for WASH services, inequities are widely observed across income groups and residential locations, with the data indicating that urban residents have greater access. Figure ES.12 shows that, at nearly all levels of per capita sector spending, more people in the urban areas enjoy greater access to water (piped water and safely managed water)

FIGURE ES.12 Correlation between WSS Spending per Capita and the Relative Access of Rural versus Urban Populations to WSS Services



Source: Authors' elaboration using per capita spending estimate in WSS in the report and WHO/UNICEF Joint Monitoring Program data https://washdata.org.
Note: WSS = water supply and sanitation.

and sanitation (sewerage and safely managed sanitation) services than their rural counterparts.

In principle, well-targeted subsidies could be designed to direct more spending to those who can least afford WSS services, especially higher-level services like piped water and networked sewerage. In practice, due to poor targeting of subsidies, errors of both inclusion and exclusion are rampant.[11] Benefit incidence analyses in 11 countries demonstrate that richer urban households receive comparatively more water subsidies than poorer rural households. Except in Viet Nam and the Dominican Republic, wealthier households in every country analyzed tended to receive more water subsidies. This regressivity is particularly pronounced in SSA.

Historical factors. It should be said, however, that in some cases the regressivity of water consumption subsidies may be a product of historical factors. For instance, the colonial history in Tanzania left the city of Dar es Salaam with a legacy of an inequitably distributed water and sewerage infrastructure that lingers on today. Piped water was provided only in those areas where the white colonial ruling class lived (World Bank 2017, 2018). Because infrastructure development is heavily capital-intensive, once it is undertaken, its spatial distribution in a city can determine for decades to come who benefits from connectivity and who does not, even when the original reasons for inclusion/exclusion have long since passed. Even today, many Dar es Salaam residents still rely on mobile tanker trucks and small carts to provide them with daily drinking water. It is, in a sense, an accident of history, but it has the persistence power of path dependency and illustrates how inclusion and exclusion patterns can be embedded in political-historical factors. These are factors that a BIA on its own is unlikely to capture unless it is situated in the context of that country's particular setting.

POLICY IMPLICATIONS AND THE WAY FORWARD

Against the backdrop of the goals set by governments and international agencies for the water sector and recognizing the predominant role of water in the economy, the sector's primary policy challenge is how to bridge the spending gap. Significantly increasing public financing is not likely to be feasible in the near term, but other options remain: (i) Increasing budget execution rates and the sector's absorptive capacity. (ii) Raising the productivity of public spending in the sector, by focusing on improving efficiency at various levels. (iii) Reducing the inefficiencies of water service providers, which contribute significantly to hidden losses in the sector. (iv) Minimizing errors of inclusion and exclusion, along with disparities in access to services, through better subsidy targeting. (v) Implementing targeted reforms to make the sector more attractive to the private sector and international capital.

In all this is the public sector's pivotal role in leading the effort to (i) improve the utilization and efficiency of public spending, (ii) catalyze additional long-term finance through reforms and targeted spending, and (iii) reform the water sector for more and better public spending.

Improving the utilization and efficiency of public spending

Reforms in public investment management (PIM) and public financial management (PFM) are critical starting points for making the utilization of public resources more efficient. First, PIM reform entails streamlining decision-making at all levels of the investment program, from strategic guidance and project selection to project implementation, evaluation, and audit. In spite of the daunting targets to be reached, the water sector is not able to use all the financial allocation that are available. A lot of money- more than one- fourth of the allocated public spending in the sector- is left on the table, untouched. This is primarily due to poor absorptive capacity of the sector, which not only calls for more systematic planning but also for simplified implementation processes across the board.

Second, to address budget execution issues. PFM reform would facilitate the flow of public funds within and across the government machinery—from the finance ministry to the line ministries, departments, and implementing agencies. Anecdotal evidence suggests that the one of the reasons for the water sector's low execution rates is the lack of predictability of funding flows and continual delays (OECD 2009). Considering the long-term nature of water sector investments, medium- to longer-term budget planning, with a focus on multi-year programs, is also vital. Additionally, tracking funds at various programmatic and functional levels of the sector is important to understand how the funds are being used.

Finally, it is important to develop a realistic performance metric of government and SOE service provision that goes beyond strict efficiency considerations alone, because the public sector often needs to make efficiency–equity tradeoffs, which can include charging prices below cost, or extending service to commercially unprofitable areas (Vagliasindi 2012).

Catalyzing the flow of long-term finance

First, with credible regulatory systems that set tariffs and service standards independent of political expediency, risk-pooling arrangements could be designed, with government and private sector support, to enable smaller water utilities that have varying performance and risk levels to access long-term capital from the financial markets as a group. They could be aggregated, administratively or financially, to facilitate borrowing, with assistance provided by government or multilateral organization guarantees. Second, broadening coverage and enhancing the quality of water sector services call for substantially more capital investment in the sector. To that end, special-purpose national or subnational financial institutions could be developed with an exclusive focus on channeling long-term finance for water and other infrastructure investments. Third, in the context of well-developed, independent regulatory institutions, public and overseas donor funds could be used—regardless of the service provider's ownership structure—as guarantees to reduce the various types of risks associated with such investments.

Reforming the water sector for more and better public spending

The above reforms must be accompanied by sector-specific policy interventions in three areas: (i) cost recovery and demand management; (ii) developing state capacity and human capital; and (iii) improving data access, transparency, and communication. First, it is useful to examine the drivers of limited cost recovery in water sector investments, which often tend to be context-specific and path-dependent. This will help to develop a hierarchy of options including injection of public resources, efficiency improvement measures and tariff revision. Demand management measures should also be introduced through a combination of pricing schemes and behavior change initiatives to reduce costs and manage scarcity. Second, consistent, long-term improvement in state capacity requires institutional and policy reforms and capacity-building initiatives to improve quality of water services. This is especially so to gather public support for initiatives, such as tariff reform, which typically encounter political challenges because of the legitimacy issues and push-back that many states and service providers face (Andrés et al. 2021). Third, to assess the credibility and effectiveness of spending flows at all levels in relation to planned, time-bound sector programs with measurable targets, the quality and completeness of water sector public spending data need to be improved. Transparent access to sector-level spending data and public expenditure tracking surveys (PETS) can improve accountability and service delivery in the water sector. All these should be coupled with a credible communication strategy to maximize popular support to reform efforts (Andrés et al. 2019).

CLOSING REMARKS

The water sector has a central role in driving economic growth, promoting human wellbeing, and sustaining the ecosystem. But as discussed in this study, a nexus of challenges related to the sector's financing and funding has cast uncertainty over the sector's current ability, and even its potential capacity, to realize its globally established targets within a desirable timeframe. With governments trying to navigate the complexities of balancing burgeoning social expenditures with limited fiscal resources, the goal of bridging the water sector's funding and financing gaps is an increasingly formidable challenge.

This real-world context makes it imperative that policymakers and other stakeholders adopt a new view of water, one that treats it as a global common good(Mazzucato et al. 2023), while recognizing its paramount significance in shaping the economy, ecosystem, and culture at the local level. This in turn necessitates a fundamental rethink of water's economics. Reshaping water markets will require policymakers to recognize water as a merit good that generates an extremely wide range of vital benefits and services for individuals, businesses, and communities, with positive-externality ripple effects that travel far. Second, adopting a global common-good lens requires acknowledging the interdependence of countries through the shared water cycle. Initiatives that embrace innovative public–private arrangements, property rights, and counter-rent-seeking mechanisms are crucial to supporting this interdependence.

As governments and international bodies strive to meet the sustainable development targets set for the sector, a multipronged strategy emerges as perhaps the only way forward. While the public sector remains, for the foreseeable future, the bedrock of funding, other players from the private sector and the international economy must be incentivized, through the creative use of risk-pooling arrangements, public sector guarantees, and the injection of catalytic capital, to invest more, and more often, in the sector. Unlocking the water sector's true potential will also necessitate enhancing execution rates and addressing deep-rooted inefficiencies. As highlighted thoroughly in this study, the interconnectedness between budget execution, factor productivity, and efficiency underscores the comprehensive nature of the challenge to overcome the sector's financing gap. Offering equitable and universal access to safely managed water and sanitation services, even in the more remote regions, also highlights the importance of spending judiciously, which in turn points to the need to gain an accurate, comprehensive, data-driven, 360° view of sector expenditures.

If resources are successfully channeled toward both financial prudence and inclusive service provision, the water sector may be able to bridge its financing gap in a way that positions the world to achieve its development targets for the sector and beyond, especially when a multitude of formidable challenges lie just ahead of us.

ORGANIZATION OF THE REPORT

Part 1 of the study delves into the historical context and rationale behind government involvement in the water sector, emphasizing the prevailing role of the public sector in the management of this critical resource and in the various aspects of its service provision.

The first of the two chapters in part 2 adapts the methodology used by Fay et al. (2019) to estimate current aggregate spending in the water sector. The second chapter estimates the spending gaps to achieve the SDG targets for the WSS and irrigation subsectors.

Part 3, which examines spending patterns in the water sector, is organized into four chapters. The first presents not only trends but also the composition of spending, using World Bank, BOOST, SPI-PPI, and OECD Creditor Reporting System (CRS) databases. The next chapter analyzes the water sector's budget execution rates and its determinants for selected countries, comparing them with those of other infrastructure and human development sectors. The third chapter quantifies the total factor productivity of public spending in the WSS subsector, followed by an estimation of the hidden losses due to water utility cost inefficiencies. The fourth analyzes the inequities in the distribution of public spending, across spatial and income groups; and the targeting performance of WSS public spending to reach a holistic understanding of the sector's financial dynamics.

Part 4 lays out a handful of policy implications arising from this study's findings. It also offers some recommendations for improving sector financing that address both the magnitude of the investments needed, and how to enhance the execution, productivity, efficiency, and equity of public spending. In conclusion, this study should serve as a valuable resource for policymakers and practitioners involved in water sector infrastructure development or financing.

Notes

1. Between 2015 and 2020, global access to safely managed water services improved from 70 percent to 74 percent, and access to safely managed sanitation services from 47 percent to 54 percent. The average annual rate of progress was roughly 0.8 percentage points and 1.4 percentage points, respectively. Thus, to achieve universal (100 percent) access on both fronts by 2030, the world would need to quadruple its current rate of progress on both fronts.
2. COP (Conference of the Parties to the United Nations Framework Convention on Climate Change) is an annual climate change summit now in its 28th year. COP26 was held Glasgow, Scotland from October 31 to November 13, 2021. COP28 will be held in Dubai from November 30 to December 12, 2023.
3. Financing and funding don't mean the same thing. Financing is the process by which a bank or other financial institution loans capital to a government or company so that it can undertake, for example, an infrastructure project. Funding is the process by which the company or government that received the financing injects that capital into the project. Financing, in other words, precedes funding.
4. The low-cost target covers the cost to subsidize only irrigation infrastructure and to promote low-meat diets, which reduces agricultural demand from livestock farming because of the reduction of cropland required for feeding livestock.
5. Estimated total global spending covers spending in the subsectors for which information was available: WSS, irrigation, water transport, and hydropower. Public spending by government entities corresponds to about $140.8 billion (lower bound estimation from part 2 chapter 1).
6. In 2017, it is estimated that nearly 80.0 percent of ODA was channeled to the public sector, including central and local government recipients. It is uncertain to what extent these funds are reflected in the government budget recorded by the BOOST database. There is a possibility for double counting to some extent.
7. Although private sector investments have frequently been discussed as a means to address the water sector infrastructure investment gap, their participation thus far has been marginal.
8. The human development sector comprises education, health, and social protection.
9. In fact, in a study of some 16,000 major infrastructure projects, only an estimated 8.5 percent finished on budget and on time (Flyvbjerg and Gardner 2023).
10. The utilities are classified into three groups- small, medium and large, based on terciles of the population coverage. Small utilities cover a population less than 18650, medium utilities cover a population rage of 18650 and 146663 and large utilities cover a population above 146663.
11. Errors of exclusion capture the share of poor households who do not benefit from a subsidy, that is, who are excluded from it. Errors of inclusion capture the share of wealthier (non-poor) households who do benefit from the subsidy.

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Abbreviations

ADB	Asian Development Bank
AE	advanced economy
AuM	assets under management
B40	bottom 40 percent of the population
BIA	Benefit Incidence Analysis
CAPEX	capital expenditures
CE	civil engineering
COP	Conference of the Parties to the UN Framework Convention on Climate Change
COVID-19	coronavirus disease 2019
CRS	Credit Reporting System
DAC	Development Assistance Committee (of the OECD)
DALY	disability-adjusted life years
DBOO	design-build-own-operate
DEA	Data Envelopment Analysis
DMU	decision-making unit
EAP	East Asia and Pacific
EC	efficiency change
ECA	Europe and Central Asia
EME	emerging market economy
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization
FCV	fragile, conflict-affected, or vulnerable (states), or fragility, conflict, and violence
GDP	gross domestic product
GFCF	Gross Fixed Capital Formation
GFCF_CE	Gross Fixed Capital Formation in Civil Engineering Works
GFCF_GG	Gross Fixed Capital Formation in General Government
GG	general government
GHG	greenhouse gas
GI Hub	Global Infrastructure Hub
HD	human development
IBNET	International Benchmarking Network
IBT	increasing block tariff
ICP	International Comparison Program
ICT	information and communications technology
IEA	International Energy Agency

IEG	Independent Evaluation Group
IFAD	International Fund for Agricultural Development
IHA	International Hydropower Association
IMF	International Monetary Fund
IWRM	integrated water resources management
JMP	(WHO/UNICEF) Joint Monitoring Programme
LAC	Latin America and the Caribbean
LIC	low-income country
LIDC	low-income developing country
LMIC	lower-middle-income country
MENA	Middle East and North Africa
MIC	middle-income country
MPI	Malmquist Productivity Index
O&M	operations and maintenance
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OLS	ordinary least squares
OOF	other official flows
OPEX	operational expenditures
PECH	pure efficiency change
PER	public expenditure review
PETS	public expenditure tracking survey
PFM	public financial management
PIM	public investment management
POF	(Brazil) Pesquisa de Orçamentos Familiares (Consumer Expenditure Survey)
PPG	public and publicly guaranteed (debt)
PPI	private participation in infrastructure
PPP	public–private partnership
R&D	research and development
SA	South Asia
SARS	severe acute respiratory syndrome
SARS-CoV-2	severe acute respiratory syndrome coronavirus 2
SDG	sustainable development goal
SECH	scale efficiency change
SFA	stochastic frontier analysis
SOE	state-owned enterprise
SPI	SOE and other public sector-funded infrastructure (database)
SSA	Sub-Saharan Africa
T60	top 60 percent of the population
TDS	total debt service
TFP	total factor productivity
TFPCH	total factor productivity change
TWh	terawatt-hours

UMIC	upper-middle-income country
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VGF	viability gap funding
WaPER	Water Sector Public Expenditure Review
WASH	water, sanitation, and hygiene
WBGI	Worldwide Governance Indicators
WDI	World Development Indicators
WFP	World Food Programme
WGI	Worldwide Governance Indicators
WHO	World Health Organization
WRM	water resources management
WSS	water supply and sanitation

PART 1

STATECRAFT

The Role of Government in Water

Setting the Stage

Introduction

Water is the basis of all life on our planet. Since ancient times, civilizations have emerged and prospered around river basins. Humans began to develop settled societies in river basins that offered fertile land and the possibility of surplus production. Throughout human existence, water availability, including its extreme forms as floods and droughts, has profoundly affected the prosperity and wellbeing of the surrounding populations. Water has therefore always been at the heart of economic progress: by connecting people, places, and goods, it contributes both directly and indirectly to economic growth, human capital formation, and poverty reduction.

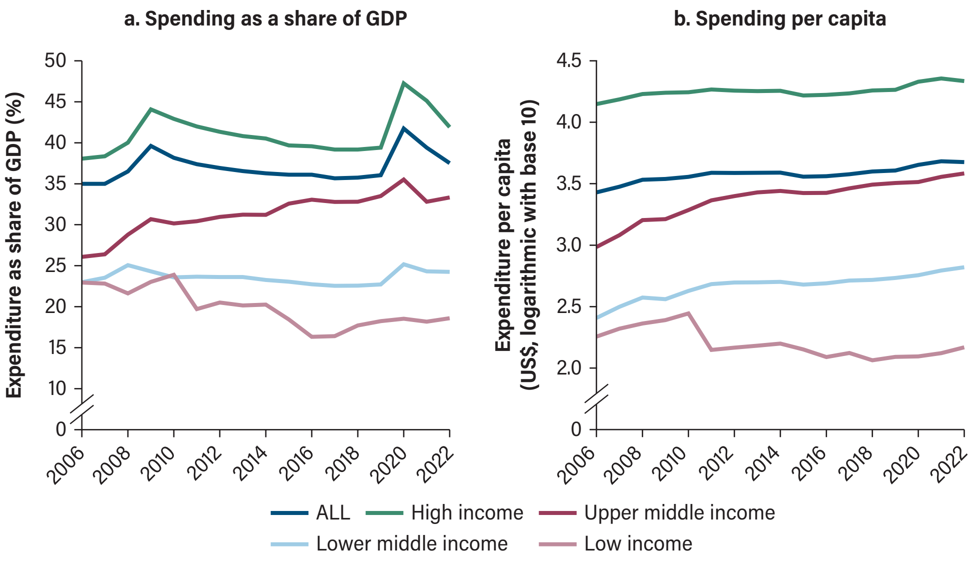
Today, however, as the global population rises and competition for water mounts, water stress, often seasonal but sometimes perennial, has emerged in several countries. With rising incomes, an expanding middle class, and rapid urbanization, the demand for irrigation water and better-quality drinking water and sanitation services has increased, especially in the developing world. Furthermore, with the onset and intensification of climate change, water availability and water management are increasingly intertwined with the development challenges many populations are facing. Taken together, climate change, widening climate variability, rapid urbanization, and the increasing water footprint of both agricultural and industrial production are accentuating water stress. As cities and populations grow, and as uncertain and erratic climatic patterns become the norm, the water sector's investment needs are also increasing.

Over the past centuries, and throughout the world, the role of the government in national life has changed in response to new political, economic, and social developments. Several characteristics of water resources—its common-pool nature, consequent challenges from over-extraction, overall positive benefits to the community from widespread use, and the natural monopoly characteristics of networked service provision—give the government an indispensable role in the water sector. Historically, governments have played an active role in managing water resources and facilitating the provision of water services through institutional and regulatory frameworks and service provision arrangements.

Governments provide public goods and redistribute resources through a mix of fiscal policy tools such as government spending and taxation (Tanzi 2011). As frequently demonstrated in history—most recently and memorably during the Great Recession of 2008–09 and the recovery efforts following the onset of the COVID-19[1] pandemic in 2019—public spending plays a critical role in boosting effective demand in the economy (Keynes 1936). It enables governments to purchase goods and services and facilitate socially desirable distributions of essential resources among the population. Many nonetheless argue that increased public spending financed by taxes or deficits, in addition to promoting clientelism and state capture by interest groups, can eventually raise the interest burden on current and future generations, crowd out private investment, and depress growth and employment in the long run (Barro 2015).

Despite some significant differences among them, the governments of high-income countries generally spend more—both as a share of GDP and in per capita terms—than those of low-income countries (Mauro et al. 2015). As is evident from figure 1.1, from 2006 to 2022, public spending per capita in high-income countries was significantly higher than in low-income countries. In 2020, for example, it was about 134 times larger. Historically, public spending on infrastructure has always been substantial. Governments began to spend more on social welfare programs only from the beginning of the 20th century, particularly among early-industrialized advanced economies. Today, even in the developing world, public spending continues to play a significant role in sectors such as energy, transport, irrigation, and water supply and sanitation (WSS). This is driven in part by the need to improve the wider population's access to infrastructure services, and by the need to make up for the shortfall in private sector spending.

FIGURE 1.1 General Government Total Expenditure, by Income Group



Source: World Bank elaboration using World Development Indicators (WDI) and International Monetary Fund Fiscal Monitor Database.

Historical Role of Governments in the Water Sector

The state has played a large role in in directly funding, regulating, and developing credible institutions to promote investments in water infrastructure. Historically, starting in ancient times, the state served as the primary source of finance, typically through taxes and user fees, to build infrastructure that delivered irrigation and drinking water services in large urban settlements. The construction of dams and canals, along with many other water-lifting devices, dates back to the ancient Egyptians and subsequently the Greeks, who tried to control the flooding of the Nile River and develop irrigation systems (Ahmed et al. 2020). The ancient Sri Lankan kings also built a sophisticated tank-based irrigation system to manage their water resources. The irrigation works in ancient Sri Lanka, dating back to between the fourth and third centuries BCE during the reign of King Pandukabhaya (437–367 BCE), were some of the most complex irrigation systems of the ancient world (Brohier 1937; Dharmasena 2011).

Understanding of the importance of clean water and its connection to health and disease prevention, the Roman state over a 500-year period also constructed and maintained 11 major aqueducts under various emperors, including Augustus, Caligula, Claudius, and Trajan. Designed to supply fresh flowing water to the City of Rome and its provincial cities (Deming 2020), these watercourses were financed mainly through taxes, contributions from the wealthy, and user fees (Goldsmith and Carter 2015; Hodge 1992) (box 1.1). Given their cost and monumentality, the construction of a complex aqueduct also became an important symbol of power for Roman cities, rulers, and even the empire itself (Wilson 2012).

The trend toward the public financing of water infrastructure continued well into the Middle Ages. In Europe, along with the influence of Roman Law, the concept of public good, and the corvée[2], communes became important local "public" institutions for managing and "financing" infrastructure, especially in the countryside. For example, the construction and management of the Roggia Serio irrigation ditch near Bergamo in Italy, built in 1219 CE by the Commune of Bergamo, involved several communes along the banks of the watercourse. (Cassis, de Luca, and Florio 2016). Nevertheless, with the growing capacity of state control and centralization of public infrastructure spending by the late Middle Ages, the corvée was gradually replaced by earmarked taxes and became a crucial tool for infrastructure financing in Europe including water infrastructure like canals.

> ***Historically, starting in ancient times, the state served as the primary source of finance, typically through taxes and user fees, to build infrastructure that delivered irrigation and drinking water services in large urban settlements.***

In the east, infrastructure development was similarly financed mainly by the monarch and the aristocracy through tributes and taxes on land. An example is the city of Kunming, China, where successful water management was a key factor in the city's dynamic development from the 12th century onward (Zheng 2013). Meanwhile, in the South Indian kingdoms of the Pandyas, Cheras, Cholas, and Pallavas, extensive waterworks

BOX 1.1 Ancient Rome's Legacy to the Public Financing of Infrastructure

The ancient Roman Empire left the modern world an important legacy, not only through its magnificent physical infrastructure but also through innovative ways of generating public finance for its construction and maintenance.

Three approaches to apportioning the construction and maintenance costs of infrastructure emerged in ancient Rome. First, the empire solidified the principles and basis for taxation. For example, through taxation, Romans obliged many of their neighboring landowners to build and maintain public roads, as decreed in 111 BCE and reinforced by Emperor Augustus (63 BCE–14 CE) (Cassis, de Luca, and Florio 2016). The implications of this principle lasted well into the Middle Ages through the adoption of Roman Law, the corvée, and earmarked taxes.

Second, ancient Rome introduced the pay-per-use principle, originally devised for water supply, and usually for the maintenance of the infrastructure (Cassis, de Luca, and Florio 2016). Pay-per-use is still widely used today, for example, through the application of highway tolls and water tariffs.

Third, the Roman government was able to find alternative sources of finance for infrastructure construction by partnering with cities, citizens, and consumers to pay for roads and bridges (Cassis, de Luca, and Florio 2016). Such partnerships may have provided the early building blocks for modern public–private partnerships (PPPs).

were built and financed by a tax on land that was progressive, meaning that the richer the landlord, the more he paid per unit of wealth. The same was also true in the Joseon Dynasty (1392–1910 CE) in the Democratic People's Republic of Korea, where the king funded wells that served as the major sources of water. Sri Lanka's tank cascade system and related infrastructure also witnessed a significant expansion during the rule of King Parakramabhu (1153–1186 CE) and were financed primarily by tax revenues exacted on its populace (Fernando 1980; Dharmasena 2011). Many of these ancient tanks still exist today, providing irrigation and flood management services for agriculture throughout the country's dry zone (Kekulandala, Jacobs, and Cunningham 2020; Hewawasam and Matsui 2022).

In more recent modern history, many of the most successful water and sanitation infrastructure projects have been financed with public funds and led by public entities. In the 1880s, authorities in London, concerned about polluted shared water sources, unaffordable service rates, and the spread of water-borne infectious diseases like cholera, began to regulate and subsidize water services for urban residents. Soon, the development of drinking water supply service technology and the improvement of public health in cities created pressure to extend these services to non-urban communities as well. Additionally, in the wake of "last mile" connection problems in New York and Paris, wherein some households could not or would not connect to networked water supply and sewer services, state and municipal governments in the US and France began enacting policies to address the bottlenecks. (box 1.2). These policy responses typically include price controls, cross-subsidization, and strict regulations compelling landowners to connect to piped water and sewer networks whenever available.

BOX 1.2 A Tale of Two Cities—The "Last Mile" Sanitation Connection Problem

History tells us that water supply and sanitation services and infrastructure have been instrumental to making Western cities more livable (Glaeser and Henderson 2017). A key step that cities took was to address last-mile connectivity issues, which today occur in developing-world cities. As in the past, today's last-mile connection challenges involve the problem of connecting households to the sewerage or piped-water network. How Paris and New York, during the late 19th and early 20th centuries, addressed this issue through regulations and pricing policies offers insightful lessons.

In late 19th-century Paris, sewer connections were not considered a public good. Only the wealthy had access to them. This created a major public health problem. There were sewer networks readily available for connection, but the cost to connect was exorbitant, roughly an annual fee of 60 francs per downpipe—equivalent to about three weeks' wages for a typical worker, over $1,200 today. By comparison, the average annual rent for an apartment during that period was some 300 francs (Kesztenbaum and Rosenthal 2017). Connections to the Paris sewer network were therefore slow to pick up. Even by 1885, only 100 buildings out of 65,000 had been connected.

To stimulate uptake, the city lowered the connection costs for building owners in poorer neighborhoods and made it mandatory for buildings to connect to the sewer network by 1894. Although that policy was not very stringently enforced, by 1913 almost 70 percent of the buildings had been connected, despite some continuing income-related bottlenecks. By 1928, although the sewer connection rate had risen to 85 percent in the top-quintile income group, poorer households were still slow to connect, with the rate ranging between 67 and 77 percent in the bottom quintile (Kesztenbaum and Rosenthal 2017). Thus, 19th-century Paris's experience shows that if the connection decision is left in private hands, bottlenecks in connecting dwellings will persist, especially in poor neighborhoods.

The construction of New York's Croton Aqueduct offers interesting parallels and contrasts. Although an engineering marvel, the Aqueduct, completed in 1842, failed to address the city's cholera outbreaks for another 24 years. As in Paris, it was a last-mile problem. The city had piped water service that most tenement owners could not afford. Poorer households carried water from water hydrants and from shallow, often contaminated, wells. In 1854, during the third international cholera pandemic, the disease killed about 2,000 New York City residents.

Despite this, the Aqueduct, even by 1865, was supplying only about 6,000 well-off families. The cholera outbreak of 1865 spurred the establishment of the Metropolitan Board of Health in 1866, headed by Dr. Stephen Smith, after which piped water connections began to increase in the city. With enforcement help from the Tenement Acts (of 1867, 1879 and 1901) and from the city's detailed records of property ownership through tax filings, the Board succeeded in implementing fines and inspections that eventually nudged tenement owners to connect to the piped-water network (Glaeser 2022).

Impressively, Dr. Smith's board carried out inspections, launched a citywide cleanup campaign, and instituted epidemic control procedures without having to rely on the corrupt police force that supposedly ran the city (Glaeser 2022). Like Smith, the doctors on the Board were reputable fellows whose integrity thwarted bribery attempts launched by business and tenement owners unwilling to incur the expense of sanitation, disinfection, and connecting to clean water. Indeed, the Board even threatened them with public exposure if they refused to connect. Eventually, these efforts succeeded (Glaeser 2022), and New York did not experience a major cholera outbreak after 1866. With increased access to clean water, the city's mortality rates also fell. The experience of New York, unlike Paris, suggests that government intervention, along with concerted political will, is often required to address last-mile issues and access bottlenecks.

Most importantly, governments played a significant role in the creation and regulation of water pricing systems. The UK's Metropolis Water Act of 1852, the first general water act applicable to London, introduced important financial regulations that, for example, placed huge investment obligations on the water companies. The companies responded by raising new capital and launching major investment programs, often with the government's support through subsidies and guarantees (Goldsmith and Carter 2015). Some government-sponsored research studies were also pivotal in alerting and swaying public opinion, and thus in reshaping laws regulating the provision of water and sanitation. For example, after the release of the Poor Law Commissioners report in 1842, a commission was established by royal authorities to examine the sanitary conditions of 50 towns in England (Goldsmith 2015). Several of the commission's reports produced findings that resulted in the 1848 Public Health Act and, eventually, the proposal to create a unitary public body responsible for both water supply and sewerage. The 1871 Amendment Act forced the drinking water supply companies to accelerate the connection of households to the network, and appointed an independent regulator, the Water Examiner, to report annually to Parliament on progress (Goldsmith 2015).

These examples serve as reminders that through time immemorial, communal water infrastructure with its sophisticated design required the support of the state. Without the investments undertaken by them, such infrastructure may not have been constructed.

Despite the critical role of the government in the sector, estimating and analyzing public spending on water infrastructure, which is fairly complex, has not been undertaken in a holistic manner. Using a variety of data sources, this study presents an integrated assessment of public spending in the water sector and in major subsectors such as WSS and irrigation, globally and across regions, with a view to providing a better understanding of the actual spending in the sector as well as funding and financing gaps in relation to sector goals, thus guiding thinking on alternative ways of addressing these challenges.

Closing the Infrastructure Gap

Infrastructure, whether transport (Cantu 2016), energy (Can, Sahin, and Demirbas 2014), or water and sanitation (Frone and Florin Frone 2014), is a key driver of economic growth (Esfahani and Ramírez 2003). Investments in infrastructure can stimulate job creation in the short term while increasing productivity, attracting private investment, and facilitating domestic and international trade in the long term (Agénor 2010; Calderón and Servén 2010; Cavallo and Daude 2011; Crafts 2009; Ianchovichina et al. 2013; Vijil and Wagner 2012). The shortage of infrastructure assets often results in reduced access to infrastructure services. Globally, in 2022, approximately 2.2 billion people lacked access to safe drinking water, and 3.5 billion did not have safely managed sanitation services (WHO and UNICEF 2023). In addition, 675 million still live without electricity, and 1 billion live more than 2 kilometers from an all-weather road, while uncounted numbers cannot access work and educational opportunities because of the absence of appropriate transport services (IEA et al. 2021, 2023; Rozenberg and Fay 2019).

Governments are periodically called on to extend, improve, or maintain existing infrastructure, yet taken together, government investment in infrastructure tends to fall short of estimated needs. For example, government infrastructure investment needs for achieving specified targets in Africa, South Asia, and Latin America was 3.5 percent, 4.7 percent, and 3.2 percent of GDP, respectively, versus estimated needs of 9.2 percent, 7.5 percent, and 4.5 percent (Rozenberg and Fay 2019). If current infrastructure gaps persist or worse widen, this could impede future global economic growth.

The argument for meeting the need for greater infrastructure investment is most cogent in low-income and middle-income countries (LICs and MICs) and in emerging market economies (EMEs) because these will play a predominant role in shaping the direction of the global economy in the coming decade. And yet the level of infrastructure capital in EMEs pales in comparison to that of advanced economies. For example, Latin America has only one-fourth of North America's infrastructure capital per worker, and Emerging Asia has less than one-fifth that of Advanced Asia (Henry and Gardner 2019). Several studies show that public investment in infrastructure has an especially large multiplier effect on output and employment. In fact, recent IMF estimates indicate that the public investment multiplier in water and sanitation is about four times larger than that of education and health (box 1.3). In the coming years, the challenge to reduce the infrastructure gap will be more complex because the opportunity cost of allocating public funds to infrastructure investments has risen significantly. In the short to medium term, many countries will be financially constrained from investing in infrastructure for two main reasons.

First, most LIC and MIC governments are hamstrung by competing fiscal demands, including public health investments, countercyclical fiscal policies, achieving their Sustainable Development Goal (SDG) targets, and debt restructuring. This hampers their efforts to direct more public funds into infrastructure investments. Based on a brief analysis of national budget data, between 2019 and 2020 public expenditure in high-income countries decreased less than it did in low-income countries (LICs) or in lower-middle income countries (LMICs) (BOOST database, to be discussed in detail later).[3] Public expenditure even increased in upper-middle-income countries (UMICs). Thus, with most of the infrastructure gap concentrated in LICs and MICs, these are the countries that are the most vulnerable to decreased productivity due to public health challenges, and climate change risks.

Second, the global economy was recently severely affected by the COVID-19 pandemic. The IMF estimated that the global economy shrunk by 3.5 percent in 2020 (IMF 2021). The negative impacts of the pandemic and of crises like the Russia–Ukraine were also felt more severely in developing and emerging market economies than in the more advanced nations (Maliszewska, Mattoo, and van der Mensbrugghe 2021). Indeed, LICs and MICs are

2021 IMF estimates indicate that the public investment multiplier in water and sanitation is about four times larger than that of education and health.

BOX 1.3 Public Investment Multiplier and the Employment Impacts of Public Investment in Sanitation

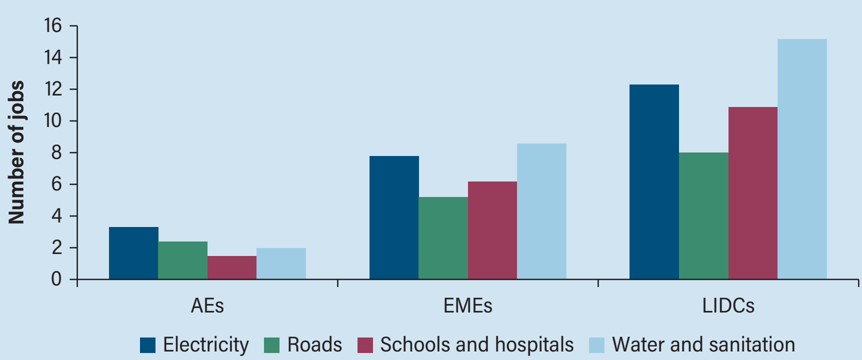
Public investments in water and sanitation have very encouraging multiplier effects. To recover from the decline in GDP induced by the COVID-19 pandemic and to boost job creation, most countries, particularly the advanced economies, announced rescue packages. The packages included substantially expanded public spending, particularly in the area of social protection. In many countries, including the United States and several European countries, the packages also involved higher public investment in infrastructure sectors. A meta-analysis assessing the actions countries took in response to the pandemic found that public investment had an average fiscal multiplier of 0.8 within a year, and approximately 1.5 to 2 within 2–5 years (GI Hub 2020). Early theoretical work by Aschauer (1989a, 1989b) and King and Baxter (1993), and more recent empirical evidence (Auerbach and Gorodnichenko 2012), have found that the public investment multiplier can be sizeable, especially because it directly improves the economy's productive capacity by increasing the marginal product of private capital and labor.

In addition, studies such as Izquierdo et al. (2019) and King and Baxter (1993) have found an *inverse relationship* between the initial stock of public capital and the impacts of public investment on output. Since a majority of EMEs and LICs have low public capital stocks, public investment multipliers can be expected to be of a higher magnitude.

The employment effects of public investment are substantial and vary from sector to sector, depending on the initial stock of capital and employment intensity. Results of an IMF study (2020) indicate that, during periods of uncertainty, in response to an increase in public investment of an additional 1 percent of GDP, employment grows by 0.9–1.5 percent over two years. Applying these estimates to total employment in the advanced economies (AEs) and EMEs suggests that increasing public investment by 1 percent of GDP would create 20 million to 33 million jobs. Because of the indirect multiplier effects of an investment, this number is significantly larger than the estimated 7 million jobs based on direct job creation.

In addition, experiences suggest that public investments have significant employment intensity. Firm-level data on revenues and employment in selected sectors, covering 27 AEs and 14 EMEs over 1999 to 2017, indicate that, in EMEs, job intensity ranges from about 2 jobs per US$1 million invested in schools and hospitals, to 8 jobs in water and sanitation (figure B1.3.1). It should be noted that, in both EMEs and LICs, job creation in water and sanitation is significantly higher than in other sectors (figure B1.3.1). In summary, public investment in the water and sanitation sector has high multiplier effects.

FIGURE B1.3.1 Job Creation in Various Sectors per US$1 Million of Additional Investment, by Country Economic Grouping



Source: IMF (2020).
Note: AE = advanced economy; EME = emerging market economy; LIDC = low-income developing country.

expected to undergo a slower and more uncertain recovery in the coming years (IMF 2021). There is therefore a need for international development actors to collaborate to bridge this infrastructure gap. This will be possible only if the global community departs from standard prescriptions, takes a fresh look at the problem, and pursues new approaches.

SPENDING NEEDS AND THE INFRASTRUCTURE GAP IN THE WATER SECTOR

Nine years into the SDG era, the world is not on track to achieve the goals for water, and this aspiration most likely will be further undermined by the aftermath of the COVID-19 pandemic and by the effects of climate change on rain patterns, water bodies, and soil moisture. For example, as of 2022, 27 percent of the global population still had no access to safely managed drinking water, and 43 percent had no access to safely managed sanitation (WHO and UNICEF 2023). Current rates of progress would need to be at least quadrupled to achieve universal coverage for safely managed drinking water and sanitation by 2030. (WHO and UNICEF 2021, 2023). Moreover, as shown by Fay and Straub (2017), there is extensive inequality of access not only across the income distribution within countries, but also across countries for households at similar income levels. The investment needed to cover this gap will depend on the cost of new infrastructure, which in turn depends on the chosen technology, the maintenance cost of existing infrastructure, and the implicit and explicit subsidies that will be needed to improve and expand service provision (Andrés et al. 2019; Abramovsky et al. 2020).

Although there are, to our knowledge, almost no estimates of spending requirements in the water sector as a whole, a number of studies have attempted to estimate the spending requirements of several water subsectors (Fox et al. 2019; Hutton and Varughese 2016, 2020). For example, it has been estimated by Fox et al. (2019) that for LMICs and LIDCs to achieve the optimal level of services and user coverage in each subsector, their overall annual spending on existing and new infrastructure—including both capital and operations and maintenance costs (O&M)—would on average need to be 0.32–0.65 percent of GDP for WSS, 0.06–1.00 percent of GDP for flood protection, and 0.12–0.20 percent of GDP for irrigation.

Cumulatively, this roughly translates to a total of US$192 billion, per year, as the lower bound and US$664 billion as the upper bound in 2017 US dollars (Rosenberg and Fay 2019). Regions with presently low access, such as South Asia and Sub-Saharan Africa, would have higher spending requirements in the WSS subsector. In some cases, the annual cost of O&M requirements exceeds capital costs, comprising 54–58 percent of the total annual spending required, because O&M costs represent a significant portion of the costs of providing water and sanitation services (Fox et al. 2019). In principle, maintenance should typically be prioritized until the rate of return is the same as maintenance and spending on new constructions (Glaeser and Poterba 2021). However, in practice, this is an unlikely occurrence.

Current rates of progress would need to be at least quadrupled to achieve universal coverage for safely managed drinking water and sanitation by 2030.

A major challenge in identifying the spending gaps based on the sector's needs or targets is the lack of comprehensive information on how much is currently being spent in the sector at the national, regional, and global levels. The studies mentioned above did not account for current spending levels. Although it is useful, when policymakers and other stakeholders are making planning decisions, to treat the spending requirements in the water sector as a function of its relevant sectoral targets, this approach may not provide a complete picture if the current levels of spending in the sector are not accounted for. Thus, this study contributes to the literature by addressing this critical knowledge gap by considering the actual levels of spending in the sector, using available data from various sources, including fiscal spending by country governments (see part 2 chapter 1), to estimate the resulting spending gaps for the WSS and irrigation subsectors (see part 2 chapter 2). By differencing (i) the estimated spending requirements (extrapolated from previous studies) and (ii) the actual levels of spending in the sector, it is possible to reliably estimate the spending or financing gaps for the sector.

Moreover, if the information is disaggregated into capital and recurrent spending, it could also reveal whether the capital investment needs, and recurrent spending needs, are being met in the sector. Finally, it would help to have a clearer understanding of the different sources of funding in the sector that come from foreign and domestic sources as well as transfers and subsidies. This would inform governments and policymakers about how to address the funding and financing gaps at various levels of water sector infrastructure investment and service provision.

Making the Case for Infrastructure Investments in Water—How Families, Farms, and Firms Benefit

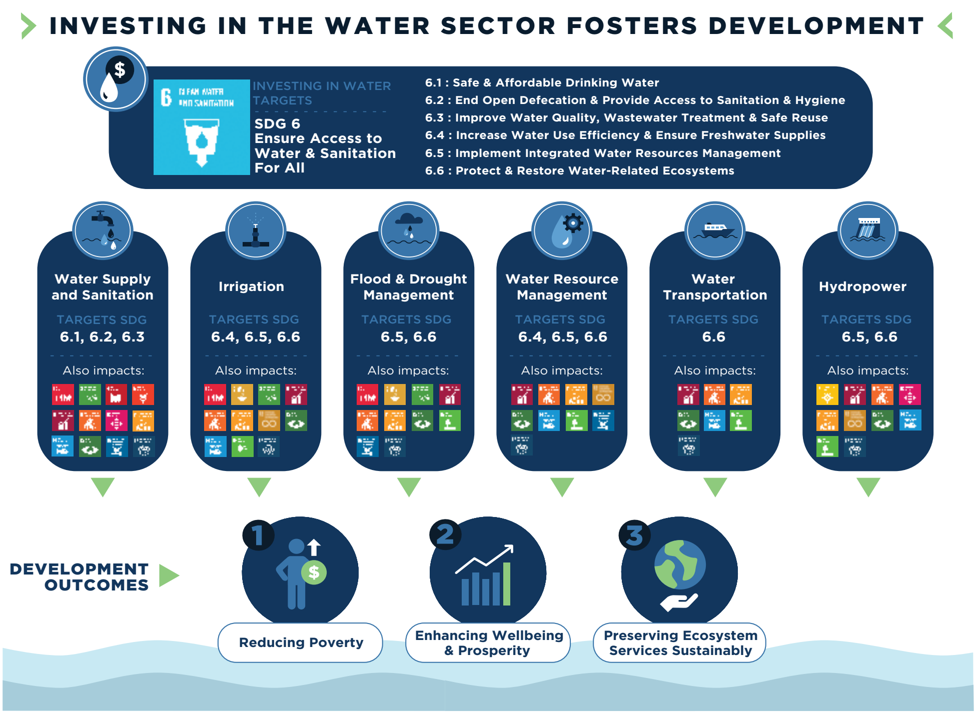
WATER SECTOR—THE NEED FOR AN INTEGRATED PERSPECTIVE

As indicated earlier, a comprehensive global assessment of public spending in the water sector does not exist, although some country-level or subsector-specific studies are available. Among academics and policymakers, there is an emerging consensus on developing a holistic approach toward the water sector that integrates the various subsectors, such as WSS, irrigation, flood and drought management, water resources management (WRM), and hydropower, rather than treating them as isolated fields. This is primarily motivated by various integrative frameworks that have emerged in the past, such as the Integrated Water Resources Management (IWRM), the Water, Food, Energy Nexus, and the Water Security approach, all of which recognize the complementarities and tradeoffs among subsectors, and the need for an integrated institutional and policy framework for the entire sector.

There is also a great need to recognize the role of water as a connector across the entire economy because of its centrality to key economic sectors such as agriculture, energy, health, and education (Andrés et al. 2018a). In fact, as figure 1.2 illustrates, besides SDG 6, which relates directly to water, the attainment of nearly all the other SDGs directly or indirectly relies on the availability of water as an input.

The transformation needed in water governance must therefore prioritize more integrated actions that span multiple sectors, and more networked policies at the national, regional, and even global levels (Mazzucato et al. 2023). Yet in most countries, responsibility for managing the water sector is dispersed across multiple national and subnational ministries, departments, and agencies that often have overlapping mandates, functions, priorities, and agendas. This affects the efficiency of water use planning as well as the allocation of finances among competing sub-sectoral priorities. For instance, Sri Lanka, with a population of just 22 million, has more than 40 agencies responsible for water (Samad et al. 2017).

FIGURE 1.2 The Water Sector, SDGs, and Development Outcomes



Note: SDG = Sustainable Development Goal.

WATER SUPPLY, SANITATION, AND HYGIENE

The targets set in the SDG for the water sector are both ambitious and costly. The primary water sector-specific SDG goals, with regards to clean water and sanitation targets, are (i) universal and equitable access to safe and affordable drinking water (target 6.1), and (ii) adequate and equitable sanitation and hygiene for all and an end to open defecation (target 6.2). As of 2022, only 73 percent of the global population had access to safely managed drinking water, and only 57 percent had access to safely managed sanitation (WHO and UNICEF 2023). It has been shown that expanding access to safely managed water supply, sanitation, and hygiene (WASH) could reduce the global burden of diseases, especially in South Asian and Sub-Saharan African LICs and MICs, which comprise a large share of the total WASH-related disease burden (Prüss-Ustün et al. 2019; Wolf et al. 2023).

Inequities in access to safe WASH facilities disproportionately impact children and women. For children under five, persistent diarrheal episodes due to sanitation-related diseases could lead to environmental enteropathy[4], causing poor absorption of nutrients and subsequently stunting and malnutrition (Humphrey 2009; Ngure et al. 2014; Zambruni et al. 2019). In fact, diarrheal diseases are among the leading causes of mortality among children under five (Prüss-Ustün et al. 2019; Wolf et al. 2023). If such diseases are not treated adequately, especially in *the first 1,000 days of life*—that critical period of childhood development between conception and age two—early-life stunting will likely have long-term implications for the child's educational attainment and long-term economic potential (Case and Paxson 2010; Cusick and Georgieff 2016; Glewwe, Jacoby, and King 2001; Glewwe and Jacoby 1995; Spears and Lamba 2016, Joseph et al. 2023).

Women, compared to men, are typically more vulnerable to the effects of inadequate WASH facilities. For example, in rural households, women and school-age girls are the ones who fetch water. If their village lacks a reliable water supply, they need to travel farther to collect water (Graham, Hirai, and Kim 2016; Sorenson, Morssink, and Campos 2011). These chores reduce the time they can spend in school and other educational activities (Dhital et al. 2021; Hamlet, Chakrabarti, and Kaminsky 2021). The lack of proper toilets also increases the risk of sexual violence against women (Gonsalves, Kaplan, and Paltiel 2015; Jadhav, Weitzman, and Smith-Greenaway 2016). Studies show that adolescent girls in Bangladesh miss about 20 percent of their classes because of the lack of menstrual hygiene facilities such as clean safe toilets (World Bank 2018). Inadequate WASH facilities in health care facilities often lead to maternal and neonatal morbidity and sometimes death (Andrés, Joseph, and Rana 2021).

BOX 1.4 Lessons from the History of Western Urbanization

Many rapidly urbanizing cities in the developing world today share similar issues and characteristics with Western cities of the past. This makes it possible to draw certain lessons from the past experience of Western cities to improve public health in the developing world (Glaeser 2021). Before the turn of the 20th century, many urbanizing cities in the West were plagued by severe outbreaks of waterborne diseases. Like many cities in the developing world today, London, Paris, New York, and Chicago—to name a few Western metropolises—all had severe outbreaks of diseases like cholera. Life expectancy was low, in certain instances lower than that of small rural towns (Kesztenbaum and Rosenthal 2017). It was not until they began investing heavily in safer WASH infrastructure, and enacting water quality standards and pricing arrangements, that the public health outlook of these cities changed, enabling them finally to reap the advantages of agglomeration without some of its grimmer ills. Over time, life expectancy increased and livelihoods improved (Beach 2021; Chapman 2019; Gallardo-Albarrán 2020; Helgertz and Önnerfors 2019; Kesztenbaum and Rosenthal 2017; Peltola and Saaritsa 2019).

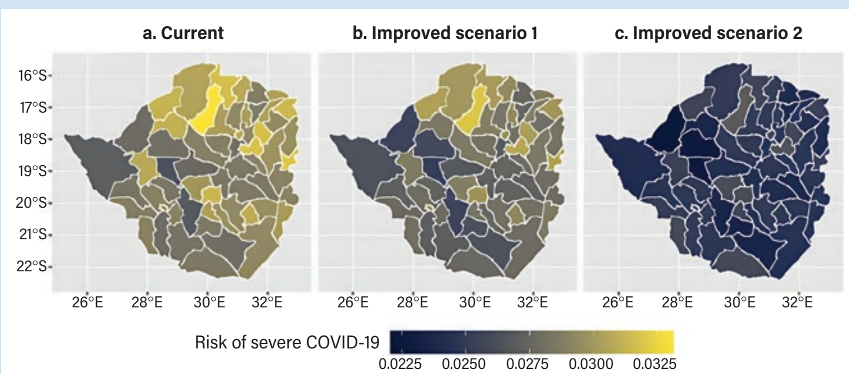
All taken together, investing and expanding access to proper WASH infrastructure at the household, institutional and community levels could have wide-ranging social benefits that could make vulnerable communities more productive and resilient (box 1.4 and box 1.5). However, as stated earlier, as it stands it would require at least a quadrupling of rates of progress to achieve universal coverage for both safely managed drinking water and sanitation by 2030 (WHO and UNICEF 2021).

BOX 1.5 Reducing COVID Risk through Handwashing: Case Study from Zimbabwe Using the Agent-Based Modeling (ABM) Approach[6]

WHO and GAVI[7] consider the lack of safely managed or improved WASH facilities a major pathway for the transmission of the COVID-19 virus (Das et al. 2020; Howard et al. 2020; WHO 2020). It is well recognized that handwashing reduces the risk of respiratory illnesses because hands harbor viral respiratory pathogens and people frequently touch their mouths and noses (Ou et al. 2020). The role of handwashing in reducing the transmission of SARS-CoV-2, given its transmission modalities, is therefore well recognized. Additionally, poor handwashing can have knock-on impacts on the number of severe COVID-19 infections because other respiratory illnesses that can be contracted through poor handwashing are also known to be COVID risk factors (Gao et al. 2021; Hu and Wang 2021; Ma et al. 2020; Ou et al. 2020; Udwadia et al. 2020) Thus, improving handwashing could reduce the prevalence of respiratory illnesses and the underlying risk in the population of developing severe symptoms from COVID-19.

Map B1.5.1 displays the results of a study in Zimbabwe (Joseph et al. 2023) that looked at whether an improvement in handwashing lowers the risk of contracting severe COVID-19. Respiratory illnesses and other risk factors for contracting severe COVID-19 (such as HIV prevalence, anemia, and obesity) already vary spatially across Zimbabwe, leading to heterogeneity in the risk of severe COVID-19 across the country—the current scenario, as shown in panel A [of Map B1.5.1]. The risk of contracting the virus vary between 2.6 percent and 3.3 percent, with Makonde, Mutasa and Marondera districts projected as having the highest risk levels.

MAP B1.5.1 Risk of Severe COVID-19 Infection among Symptomatic Cases in Zimbabwe under Three Hand-Washing Risk Scenarios, by District



box continues next page

BOX 1.5 Reducing COVID Risk through Handwashing: Case Study from Zimbabwe Using the Agent-Based Modeling (ABM) Approach (*Continued*)

In panel b (Scenario 1—Improved Handwashing), all households are assigned the highest observed district-level handwashing access (meaning that all households have their handwashing risk rating lowered to 0.25, the *lowest prevailing risk level in the country*). In panel c (Scenario 2—Much Improved Handwashing), all households have *the lowest possible handwashing risk*, that is, everybody has access to an improved handwashing facility with soap and water (a risk rating of 0).

We can see that the adjustment in Scenario 1 provides only a minimal drop in the risk (2.9 percent to 2.8 percent) while Scenario 2 (perfect access to handwashing) leads to a more substantial reduction (2.9 percent to 2.5 percent). These results indicate that handwashing could turn out to be more cost-effective intervention than extensive social-distancing measures, with their considerable economic and societal costs (Bagepally et al. 2021). Indeed, investments in WASH are likely to lead to substantial economic returns even in the absence of COVID-19. The pandemic merely makes this investment all the more urgent.

HOW WATER SUPPLY INTERRUPTIONS IMPACT BUSINESS ACTIVITY

Investments in water infrastructure and service provision have a widespread impact on the economy. For instance, in the business environment, water plays an essential role in firm productivity, and water shortages can impact performance. Water is an essential input in production, yet firms in LICs and MICs are often faced with water shortages. Data from the World Bank Enterprise Surveys show that, between 2009 and 2015, firms in LICs and MICs experienced more than twice as many water shortages—defined as incidents of insufficient water supply that the firms experienced in a typical month, over the last fiscal year—as those in upper-middle-income countries (UMICs) and high-income countries.

Water shortages also tend to last longer in LICs and MICs on average, and smaller firms experience more frequent shortages than larger ones. In addition, it is estimated that, on average, each additional water outage in a given month results in an 8.7 percent loss in sales (Damania et al. 2017; Islam and Hyland 2018). The implications of water shortages are even worse for informal firms, the most prevalent form of economic enterprise in LICs and MICs. Each additional outage is associated with a 34.8 percent loss in sales (Damania et al. 2017). Investments to expand and improve water service provision could therefore reduce the incidence of outages and interruptions, and hence the economic losses resulting from them.

IRRIGATION AND COASTAL AND RIVER FLOOD PROTECTION

The SDG goals related to irrigation are closely tied to SDG target 2, which covers food security and ending hunger. Investments and improvements in irrigation facilities could protect vulnerable communities from seasonal variation in precipitation, which, in turn, could have positive impacts on health, education, and other human development outcomes throughout the human life cycle (Damania et al. 2017). In areas sufficiently well-equipped with irrigation infrastructure, agricultural productivity shows little sensitivity to changes in rainfall patterns, indicating that the irrigation infrastructure is protecting the farmers from rainfall shocks (Damania et al. 2017).

Another beneficial effect of expanding irrigation facilities is that it disincentivizes farmers from expanding their croplands to improve production. This reduces deforestation rates (Damania et al. 2017). Investments in irrigation infrastructure therefore deliver dual benefits—to farms and to forests. Globally, the potential for expanding irrigation is significant. In 2010, just 43 percent of the land available for irrigation worldwide was irrigated, and irrigated cropland accounted for only 30 percent of total global cropland (FAO 2017; Rozenberg and Fay 2019).[5] Additionally, investments in flood protection infrastructure could prevent a substantial amount of residual damage to cropland from coastal and river floods, which are expected to increase significantly this century as sea levels rise, precipitation becomes more intense and erratic, and adverse weather events become more common (Rozenberg and Fay 2019).

HYDROPOWER

Hydropower is the world's largest source of renewable energy, but further investments are essential to ensure that it has a low-carbon footprint and to reduce energy deficits in LICs and MICs. In 2020, globally, the hydropower sector generated 4,370 terawatt-hours (TWh) of clean electricity, accounting for 15 percent of global electricity production (IHA 2021; Lyon 2020). Although the technology for this renewable source is mature and economically competitive, there is still a great deal of undeveloped hydropower capacity, ranging from 50 percent in Europe to 90 percent in Africa (Zhou et al. 2015). Globally, as of 2021, 675 million people still lacked access to reliable energy services. Hydropower investments will therefore be crucial to achieving SDG 7—affordable, reliable, sustainable, and modern energy for all—but would also contribute to food security (Dhaubanjar et al. 2021; ESMAP 2021; IEA 2021, 2023). Hydropower's contribution to the fight against climate change is also substantial because it is a clean, affordable, reliable source of electricity that also meets the needs of drinking water, irrigation, flood, and drought control (Hoes et al. 2017).

Why Government Should Take an Active Role in Leading Investments in the Water Sector

THE UNIQUE FEATURES OF WATER CALL FOR GOVERNMENT INTERVENTION

Several unique characteristics of water sector investments and service delivery make the government's active role of vital importance. These include the desirability of the increased use of safe water and sanitation services from social and health perspectives, the additional benefits that accrue to society due to individual consumption—water as a merit good—the monopoly nature of networked production, and the common-pool nature of water as a resource. These features all tend to upend the standard economics view based on an idealized, free-market, competitive world. These attributes are discussed in turn below.

MERIT GOODS

Water supply, sanitation, and irrigation services can be regarded as "merit goods." Merit goods are commodities that, although often under-produced and under-consumed, people are encouraged to have more of because these goods potentially generate positive externalities, create socially desirable outcomes, and are considered beneficial to the well-being of individuals and society. Increased availability and use of merit goods tend to enhance the standard of living of the population as a whole. Examples include water, public transport, renewable energy, sanitation, education, welfare service, public parks, green open spaces and health care. This perspective was employed when water was enshrined as a human right in Resolution 64/292 of the UN General Assembly.

Left in the hands of private providers, merit goods such as WSS will likely be under-provided and under-consumed because of households' low willingness to pay for their full true benefits, often because of affordability issues and prevailing social attitudes that reinforce the view that water, like air, should be free. Studies have demonstrated that public spending on merit goods can complement private consumption and attract complementary private investment in the sector, thus contributing to economic growth in the long run (Fiorito and Kollintzas 2004; Kotera and Sakai 2017). For example, expanding irrigation systems increases agriculture production, thereby increasing the demand for other production inputs such as fertilizers, labor, and machinery. Correspondingly, the health benefits from infrastructure investments in WASH could contribute to healthier communities that are more productive and may in return spend more, resulting in higher private consumption.

POSITIVE EXTERNALITIES IN CONSUMPTION

As discussed in the previous section, water and sanitation services are characterized by network externalities in consumption, implying that the more people use these services, the more the entire society benefits. In other words, the social returns far outstrip the individual returns. This is because consumption of water and sanitation services benefits not only the individual consumers but also those around them, for example, by reducing the probability of their becoming infected through contamination and, in turn, infecting others. Access to water and to sanitation infrastructure thus not only directly benefits the households with access but also indirectly benefits the community, including those without access. For the full benefits of water and sanitation infrastructure to be realized, investments should focus not only on improving the access of households to such infrastructure but also on achieving community-wide coverage of improved sanitation through public toilets, toilets in schools and health centers, and eliminating open defecation (Andrés, Joseph, and Rana 2021).

However, as in the case of merit goods, the private benefits to paying customers fall well below the societal benefits. As a result, private sector investment in water and sanitation—which limits itself to its paying customers and bases its pricing structure only on them—typically falls short of optimal socially desirable levels, which therefore calls for public investment.

THE MONOPOLY CHARACTERISTICS OF NETWORKED SERVICE PROVISION

Considering the large-scale infrastructure needed, service provision in the water sector tends to be exceptionally capital-intensive, with high, fixed, upfront capital costs and long payback periods. Moreover, once the infrastructure is paid for and set up, the marginal cost of providing service to an additional household is minimal. This has several implications. Building vast networks or pipes and sewage systems requires large capital investments. It is therefore usually not economically viable for a new entrant into the market to duplicate the infrastructure. Since the fixed costs of capital investments are high and the marginal cost of additional service provision is small, it is socially optimal to have the same service provider serve the entire customer base, subject to the capacity of the infrastructure. This, in turn, helps the service providers to achieve economies of scale and reduce their average unit price.

This means that competition in the water sector is typically undesirable because it tends to reduce the number of customers a provider can serve, and hence reduce economies of scale (box 1.6). The optimal way is to provide services through a single infrastructure built and managed by a single provider—in effect, a monopoly. A private-sector service provider handed a monopoly will tend to engage in profit-gouging behavior by hiking prices, reducing service quality, and crowding out the poor.

On the other hand, the provider's high fixed costs tend to result in high average costs of service provision, so they will incur losses if they charge no higher than the marginal cost as they provide service to more and more consumers. The solution would be for the government to intervene with regulations that ensure affordable prices, yet also ensure that the service provision is financially viable. Not surprisingly, under such conditions, private-sector investors are deterred from investing in the water sector.

BOX 1.6 The Private Sector, Competition, Subversion, and Water Services: A (Mis)match Made in Heaven?

The Private Sector and Competition in London

As previously discussed, competition among private water service providers may result in poor service, requiring government intervention and regulation to ensure adequate standards. A good example of this occurred in 19th-century London.

At the turn of the 19th century, the quality of service provided by four of the eight main privately owned water companies in London (London Bridge Waterworks Company, New River Company, York Buildings Waterworks Company, and Chelsea Waterworks Company) was no better than it had been 200 years earlier (Goldsmith and Carter 2015). Because of various cost-cutting measures as well as aggressive (and costly) marketing campaigns to try to stay ahead of the competition, these companies offered very basic, low-pressure, piped-water connections. Water also was not available every day, usually only 3–4 times a week (Goldsmith and Carter 2015). Although it could be argued that the London Water Wars between 1810 and 1820 did result in some progress—for example, the adoption of cast-iron pipes over the old wooden ones by big new water companies—the business model for wooden pipes was already unsustainable because of timber shortages and a tripling of wood prices within 20 years, from 50 shillings per load in 1790 to 150 shillings in 1810, driven in part by the French Revolutionary Wars of 1792–1802 (Tomory 2017). Still, progress in terms of quality of service was very slow after 1820, until strict regulations were introduced.

As a result, from the 1830s to 1860s, there were at least four documented cholera outbreaks in London. It was perhaps not until after the English physician and epidemiologist John Snow, in 1854, famously identified contaminated water as the source of disease transmission, and the subsequent enactments of the Metropolis Water Acts (1852 and 1871) and the Public Health Act of 1875, that water companies began to provide better quality services (Goldsmith and Carter 2015). By the 1870s, all of London's water companies were strictly regulated and required to provide their users with high-pressure, continuous water. By 1904, the eight private water companies still operating in London had been absorbed into the Metropolitan Water Board (Goldsmith and Carter 2015).

The Private Sector and State Subversion: The Case of New York

When government pays a private firm to perform a public service such as water provision, the private company, under certain circumstances, has an incentive to bribe or subvert the government to increase the level of subsidy or support, and/or allow the firm to get away with reducing the quality of the service (Glaeser 2021)—essentially, more money for less service. This was the case with the Manhattan Water Company.

Before the construction of the Croton Aqueduct, New York City commissioned the Manhattan Water Company to provide the city with water but the company did little to solve the city's clean water issues (Glaeser 2021).[8] The company was in fact more interested in engaging in the lucrative banking industry and was little more than a front for the bank it planned to set up. During the negotiations, it even induced the government to slip what amounted to a subsidy into the company's charter—a provision buried in the fine print that enabled it to engage in banking and earn extra money that way. Within five months of starting operations, Manhattan Water Company's bank had begun doing business on Wall Street. An important lesson here is that strong, stable political-legal-administrative institutions are required to forestall the subversion of the state, especially in the context of public–private partnerships (Glaeser 2021).

Private provision of service therefore seems to be a more suitable mode in sector settings, such as transportation, that closely resemble standard markets, and less suitable to public goods such as water (Glaeser 2021), where there are no markets that can punish a company for subpar products or services. Where users pay for most of the cost of a service, as they do in standard markets, there is

box continues next page

BOX 1.6 The Private Sector, Competition, Subversion, and Water Services: A (Mis)match Made in Heaven? (*Continued*)

no need for subsidies or incentives. Private firms are naturally incentivized to provide good service, as in the case of 19th-century London's private water providers (although, in that particular case, competition among the private providers ultimately drove down the service quality). The main risk of commissioning a private firm to provide public goods such as water—essentially, to buy or sell directly to the government—appears to be that the private provider may influence the government for unjustifiably advantageous terms, as in the case of the Manhattan Water Company (Glaeser 2021).

COMMON-POOL CHARACTERISTICS AND NEGATIVE EXTERNALITIES IN PRODUCTION

Water resources are a finite, non-excludable, rival, common good. A common good—examples of this are water, clean air, public roads, and national defense—is non-excludable. In other words, it is difficult or impossible to exclude others from extracting water from a given source or, in some cases, to force them to even pay for it. In the absence of clearly defined property rights, anyone can access available water resources from rivers or lakes, and even beneath the ground, and it is difficult to restrict anyone from using them.

Water resources are also rival goods. This implies that, unlike nonrival goods such as radio shows or TV broadcasts, water abstraction by one user prevents other users (rivals) from simultaneously abstracting that same water. Only one user can use that portion of water. The remaining water resource diminishes by the amount used.

When these two features—non-excludability and rivalry—combine, it creates challenges to the sustainability of common-pool resources in the long run. When the demands of rival users are in competition, demands from different users for a finite amount of water mean that each user will try to secure their needs at the expense of the others and of the stock of resource itself, leading to the "tragedy of the commons"—the deterioration of a common public resource because users with access to it act in their own short-term interest and ultimately deplete it beyond recovery (Hardin 1968; Shalsi et al. 2019).

On the other hand, the difficulty of exclusion causes problems in both the capacity for the water resource to renew itself and the deterioration of the resource system, whether through depletion or pollution. Ultimately, if left unregulated, this will lead to the overexploitation of the common-pool resource or the pollution of the water source, such as wetlands and rivers. Around the world, particularly in South Asia, groundwater is being depleted by overextraction that is typically unregulated (Jacoby 2017). Regulation of common-pool resources such as water is thus needed to prevent the depletion of water resources, and that typically entails government intervention.

It is concerns like these that are driving the emerging view that a common-pool resource such as water ought to be considered a global common good (Mazzucato et al. 2023). The notion comes from two growing observations: first, that more and more people from different nations are interacting in multiple ways within an increasingly interconnected, interdependent world, where occurrences in one region—from war and migration to epidemics and recessions—have spillover or knock-on effects elsewhere (Hollenbach 2002); and second, that although commercial transactions and business services, from healthcare delivery to waste management, are increasingly being privatized, certain common goods—water, environmental sustainability, primary education, rainforest carbon sinks, pandemic vaccines—continue to reflect the collective aspirations, common purposes, and shared responsibilities of all the members of our interconnected global community, and should be recognized as such.

The world would therefore do well to maximize and leverage the public values, positive externalities, and near-universal participation that certain goods represent, by moving their valuation, provision, coordination, and management within a global framework that balances and distributes obligations, responsibilities, and benefits fairly and equitably.

Water has special features that arguably make it a good candidate for recognition as a global common good. On the one hand, the nature of the water cycle generates interdependence among countries. For example, to sustain precipitation within their national borders, even the largest countries—Russia, Canada, China, the US—rely on evapotranspiration[9] from forests on the other side of the world. In other words, the transboundary nature of water means that countries depend on each other to sustain their water resources. Rivers, lakes, and groundwater in various national administrative jurisdictions are becoming areas of cross-border water governance arrangements that often trigger international disputes. In short, water is not only an increasingly global problem but also an integral part of other global challenges such as climate change, food security, rapid urbanization, and water-borne epidemic diseases.

Discussion

The points highlighted in the preceding sections of this chapter, taken together, have multiple implications for the water sector. To summarize them: Market conditions—meaning the efficient determination of prices through the voluntary exchange of goods and services among a large number of buyers and sellers—do not exist for the water sector. Competitive pricing, enabled by the efficient allocation of resources in an ideal free market world, does not work well in the water sector because of externalities and its public good and common-pool resource characteristics. Throughout the world, even in the most advanced market economies, water resources are owned primarily by states or other public institutions. Significant renewable water sources like rivers and lakes are held as national or common property resources. Private property rights over water are limited and often linked to land ownership. Water utilities that supply water for drinking, sanitation, and other household uses are typically state-owned. And because of externalities, the private benefits of water consumption are often surpassed by its social benefits.

All these circumstances point to the need for government intervention to set the rules of the game and provide institutional arrangements for the regulation and management of the sector to ensure equity and long-term sustainability. The precise nature of government intervention varies from country to country and depends on several factors, including the political and economic context, the stability, robustness, and accountability of institutions, the presence of significant actors at various levels, the level of maturity and independence of the water sector and governance institutions, the size, maturity, liquidity, and sophistication of the financial sector and of the private sector, and the size and nature of foreign flows such as aid and private investment. With so many variables in play, the public sector typically does not have a preformulated solution it can just implement. It needs to engage in iterative experimentation with different policies and approaches based on reliable data, historical experience, and successful practices from elsewhere. This is a process governments are best placed to lead, with cooperation from the private sector and other stakeholders.

Despite the challenge of getting the financing, funding, regulation, and management of the water sector right, a comprehensive, systematic assessment of expenditures in the global water sector has yet to be undertaken. This study aims to fill this gap. Although public expenditure reviews of the water sector, or of major subsectors like WSS and irrigation, have been undertaken in several countries, the trends and size of the sector at the global level need to be assessed and compared with its spending needs, both overall and at the subsector level. This is particularly important for achieving the SDG targets because it would allow the global community—international organizations, national and subnational governments, the private sector, and other stakeholders—to identify fresh new synergies that could be harnessed to create options for covering the spending gaps. Moreover, for better utilization of available resources, the efficiency of water sector public spending needs to be evaluated in order to understand the gaps in spending efficiency and to explore possibilities for improvement.

More evidence on how well the public funds are being spent in the sector, and whether the benefits are reaching the socioeconomic groups most in need of them, also has to be gathered. This study is therefore aimed at informing a broad spectrum of stakeholders in the water sector and related subsectors to enable them to engage in improved decision-making, and to facilitate reforms that will help increase funding in the sector while enhancing efficiency in the use of existing resources to maximize development impact.

Notes

1. The formal name of the virus that causes the disease COVID-19 is SARS-CoV-2, which stands for Severe Acute Respiratory Syndrome (SARS) coronavirus.
2. Corvée is a form of unpaid, intermittent, forced labor imposed by the state or a landlord for the purpose of undertaking public works. Originating in ancient Rome and later adopted in Medieval Europe, China, and other parts of the world, it took one of two forms: infrastructural corvée (roads, bridges, aqueducts) or agricultural corvée (farmland). A certain number of days a year, tenant farmers, for example, might be required to perform corvée work for their feudal landlord. Corvée represented a form of taxation, so one could perform corvée in place of paying taxes.
3. BOOST is not an acronym. It is the name of a user-friendly data tool that facilitates access to, and analysis of, public expenditure microdata.
4. Also known as tropical enteropathy, environmental enteropathy is a small intestine disorder marked by a generalized state of intestinal inflammation that results in multiple changes to the gastrointestinal tract, including damage, irritation, and swelling of the small intestines. Signs include reduced absorptive capacity of the intestines, and hence malnutrition, anemia, stunted growth, and impaired brain development. Its causes are multifactorial, but the main ones are long-term exposure to poor sanitation and hygiene, especially repeated exposure to fecal contamination. It is widespread among children in low-resource, low-income settings.
5. However, although mechanized irrigation usually protects farmers from the adverse effects of drought and rainfall variability, it can in some instances amplify the impacts of such shocks, especially in dry regions of the world. The availability of irrigation water through irrigation systems for cheap or for free can create a false illusion of abundance among farmers. This can lead them to switch to cultivating more water-intensive crops such as rice and sugarcane that are otherwise not suitable for cultivation in dry regions (Damania et al. 2017). While farmers may consider this a desirable outcome, switching to water-intensive crops may increase their vulnerability to dry shocks when the special water needs of these crops cannot be met (Damania et al. 2017).
6. See Joseph et al. (2023).
7. GAVI stands for the Global Alliance for Vaccines and Immunization. The group has officially changed its name to Gavi, the Vaccine Alliance.
8. It is of interest to note that, half a century later, the Manhattan Company, which in 1808 had spun off its water business after only nine years to focus purely on banking, merged with Chase National Bank in 1955 to form Chase Manhattan Bank, which eventually became the current JPMorgan Chase & Co. It gives additional substance to the view that, from its very inception, banking was in its blood and had been its objective all along.
9. Evapotranspiration, as the name suggests, is the movement of water from the earth's surface into the atmosphere through (i) evaporation from the soil and from water bodies, and (ii) transpiration. Transpiration is the release of water vapor into the air from plant leaves. How much? A single acre of corn releases 3,000 to 4,000 gallons of water in a day, and a mature oak tree can release more than 40,000 gallons of water a year.

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PART 2

MONEY MATTERS

What Is Spent and What Is Needed?

CHAPTER 2.1

More is Better

KEY MESSAGES

- The fragmented nature of the water sector poses a challenge for governments and policymakers seeking to adopt a unified approach to managing the sector financially.
- This chapter takes a holistic approach to estimating public spending in the water sector, encompassing expenditures in the irrigation, water transport, hydropower, and water supply and sanitation (WSS) subsectors. This comprehensive approach offers a more complete understanding of spending in the water sector.
- Annual public spending in the water sector is estimated to be $140.7 billion, a lower-bound estimate. Total spending if the private sector is included—the middle estimate—is $143.5 billion. If SOEs are also included—the upper-bound estimate—annual spending would be $153.2 billion in 2017 constant prices.
- These figures correspond to 0.45 percent, 0.46 percent, and 0.49 percent of GDP, respectively.
- More than half of the total water sector spending, estimated to be between $79.9 billion and $90.7 billion, or 0.25–0.29 percent of GDP, goes to the WSS subsector.
- Annual capital expenditure (CAPEX), ranging between $114.5 billion (0.36 percent of GDP) and $123.8 billion (0.39 percent of GDP), accounts for about three-fourths of total water sector expenditure.
- Annual capital spending on WSS is estimated to be between $60.9 billion (0.19 percent) and $69.0 billion (0.22 percent).
- Low- and middle-income countries (LICs and MICs) spend between $128.6 billion (0.44 percent) and $139.6 billion (0.48 percent) a year on the water sector, about $69.5 billion (0.24 percent) to $79.0 billion (0.27 percent) of which is dedicated to WSS.
- In regional terms, East Asia and Pacific (EAP), including China, spent the most in both the water sector and the WSS subsector.
- Annual total spending in the irrigation subsector amounts to about $2.3 billion in 2017 constant prices, corresponding to 0.05 percent of GDP.
- Spending in the water sector can positively impact development outcomes beyond SDG 6, including improved human development outcomes such as reduced stunting, increased human capital development, and decreased poverty.

The Challenge of Estimating Public Spending in the Water Sector

TWO BIG HURDLES

In recent years, pandemic-related shutdowns have imposed fiscal constraints on revenue-starved local and state governments, and water utilities have faced challenges in providing uninterrupted service amid reduced revenue and shortfalls of key inputs (World Bank 2020a). Despite this, countries have had to continue prioritizing their water supply and sanitation services, for one simple reason: Adequate, affordable, safe water is fundamental to economic growth and human capital development. Indeed, many challenges related to climate change, food insecurity, and rapid urbanization are closely tied to water. The COVID-19 pandemic, for example, underscored the indispensability of a well-managed water supply system to a functioning society as handwashing emerged as the first layer of defense against transmission. In light of this, world leaders attending the UN Climate Change Conference COP26 in October/November 2021, and COP27 in November 2022,[1] set global goals advocating an increase in water sector investments because of the crucial role water plays in climate change adaptation and mitigation.

Despite water's fundamental role in the economy, two major hurdles continue to foil attempts to estimate the extent of public spending in the sector. First, to date, no comprehensive global or country-level estimates of actual spending in the sector exist, which are needed if policymakers are to understand the extent to which investments are falling short of meeting financing needs. Prior to this report, a "whole-of-water" approach to estimating capital and recurrent water expenditures at a global scale had not been undertaken. Previous water sector public expenditure reviews typically focused on individual subsectors such as irrigation or WSS and were confined to country-level analysis (see table H.1 for a list of countries where water sector or subsector public expenditure reviews were recently conducted). As a result, earlier efforts to estimate the so-called "infrastructure spending gap" have not accurately assessed the actual levels of spending in the sector, offering instead an oversimplified account of "*the spending gap*" that needs to be closed to achieve the sector's goals.

Second, besides the lack of comprehensive, detailed estimates, the fragmentation of institutions and investments in the water sector poses itself as another major hurdle. The fractured and decentralized nature of the sector hinders the adoption of an integrated approach to water resources management (IWRM). Although many countries recognize the importance of developing a consolidated approach to managing the water sector, most lack an institutional governance framework for IWRM. In most countries, a plethora of entities are tasked with the allocation, management, and regulation of water resources, each with their own set of policies, personnel, organizational culture, and budgets. Limited coordination and communication among these overlapping entities lead to difficulties in crafting an integrated development plan for the sector that offers a clear roadmap for investment, expansion, or improvement.

Prior to this report, a "whole-of-water" approach to estimating capital and recurrent water expenditures at a global scale had not been undertaken.

AN INTEGRATED APPROACH

A first step toward a consolidated, holistic strategy would be to take an integrated approach to understanding public spending in the water sector. This would help bridge the knowledge gaps and enhance the exploration of synergies and tradeoffs among the various water subsectors. A comprehensive account of spending levels in the water sector is crucial for reaching an accurate, and unified 360° picture of the financial requirements of achieving various targets, particularly, SDG targets 6.1 and 6.2.

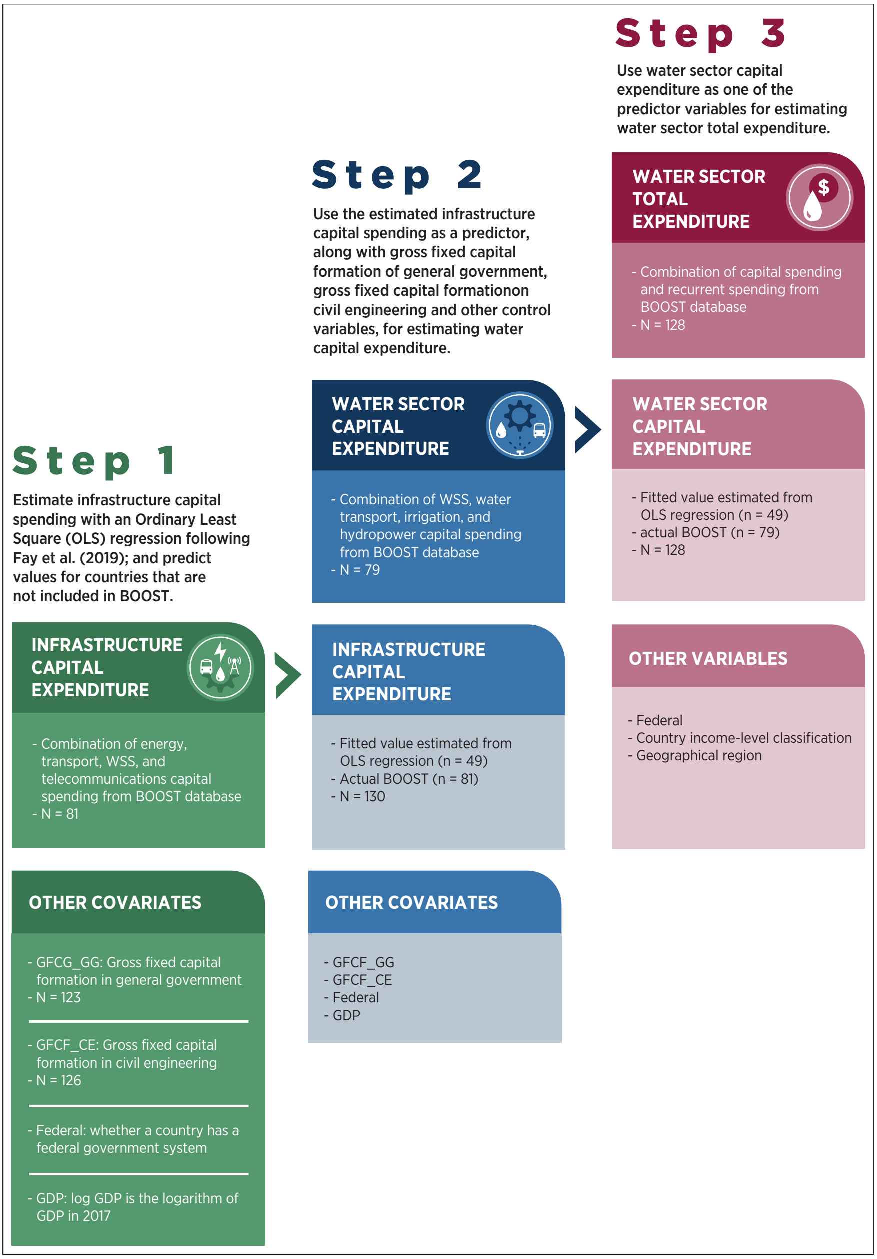
The current chapter therefore focuses on estimating the magnitude of aggregate public spending in the entire water sector, comprising the WSS, irrigation, water transport, and hydropower subsectors. Sectoral spending estimates for the overall country-level water sector, and for the WSS subsector, in 130 countries are presented at the global and regional levels. Additionally, capital and total expenditures in irrigation for 32 and 41 countries, respectively, are presented.

For the first time, therefore, the analysis presented here estimates levels of actual spending in the sector. It builds on the work of Fay et al. (2019), who have developed a robust methodology for estimating total infrastructure capital spending[2] in multiple countries using budget and other data on gross fixed capital formation. An added challenge in undertaking this analysis has been aggregating expenditures in a fragmented sector that spans several different ministries and departments that often have limited information on budget categories such as economic, administrative, and functional classifications.

Estimating the Water Sector Spending: Nuts and Bolts

To estimate total spending in the water sector, a modified version of the econometric approach employed in Fay et al. (2019) for estimating infrastructure capital expenditure is used, described in figure 2.1.1. The approach for estimating capital, recurrent and total expenditure is set out in technical appendices A and B. Briefly, the econometric approach for estimating total water sector spending has four steps. First, infrastructure capital spending is estimated following Fay et al. (2019), using the latest available BOOST data and data on Gross Fixed Capital Formation of General Government (GFCF_GG), from the International Monetary Fund (IMF), and Gross Fixed Capital Formation on Civil Engineering Works only (GFCF_CE) data from the International Comparison Program (ICP 2017). Second, the estimated infrastructure capital spending is used as a predictor, along with Gross Fixed Capital Formation and other control variables, for estimating water sector capital expenditure. Third, water sector capital expenditure is used as one of the predictor variables for estimating water sector total expenditure. Finally, recurrent expenditure is computed as the difference between total expenditure and capital expenditure. The same approach is used to calculate WSS subsector expenditure.

FIGURE 2.1.1 Flow Chart of Econometric Approach to Estimating Capital and Total Expenditure in the Water Sector



Source: Authors' elaboration.
Note: GFCF_GG = Gross Fixed Capital Formation in General Government; GFCF_CE = Gross Fixed Capital Formation in Civil Engineering Works.

BOX 2.1.1 Quick Summary of the Four Datasets

- **National fiscal data:** These are data on expenditure flows from treasury systems that are available from the BOOST database managed by the World Bank and funded by the Bill & Melinda Gates Foundation. The number of countries covered in the dataset rose from 55 in 2019 to 81 in 2021.
  - Excludes data on private sector investments, off-budget spending by the government, sectoral spending if national budget classification data do not clearly identify sectoral spending, and investments by state-owned enterprises (SOEs), except for national budgetary capital transfers. The latter is a major issue given that SOEs constitute a considerable share of the water and sanitation and the electricity sectors, and much of the transport sector.
  - Small risk of including non-infrastructure spending
  - Available on an annual basis and allows for in-depth sectoral analysis.
  - Time-consuming for countries with insufficient functional classification
- **Gross fixed capital formation of general government:** Captures gross fixed capital formation by central, state, and local governments, as reported by the IMF in the Investment and Capital Stock dataset for countries.
  - Excludes data on private sector investments and investments by SOEs.
  - Includes data on residential dwellings, and on non-infrastructure sectors such as health, education, defense, and mining.
  - The available data have no sectoral breakdown.
  - Wide coverage of countries, with data on 165 countries and consistent measurement across countries. For the analysis, this study uses a sample of 123 to be consistent with Fay et al. (2019)
- **Gross fixed capital formation in civil engineering works:** Captures expenditure on construction, excluding buildings from the World Bank's ICP database.
  - Excludes non-residential buildings (airport terminals, railway stations), machinery and equipment (turbines, locomotives)
  - Includes civil engineering works in non-infrastructure sectors (mining, irrigation, recreational facilities)
  - The available data have no sectoral breakdown.
  - Wide coverage of countries, with data on 175 countries (although limited time-series) and consistent measurement across countries. For the purpose of analysis, this study uses a sample of 126 to be consistent with Fay et al. (2019)
- **Private and Public Investment on Infrastructure:** From the World Bank's Private Participation in Infrastructure (PPI) database, on private participation in infrastructure projects, and from the SOE/Public Projects (SPI) database, on publicly reported data on infrastructure projects sponsored by SOEs and other public entities.
  - The PPI data record commitments rather than actual spending, and do not track fully privatized investment.
  - The PPI data are disaggregated by sector and collected annually.
  - It is time-consuming to remove the public share of project financing to avoid double counting.

Figure B1 2.1.1 provides a description of the three main datasets used in the econometric exercise.

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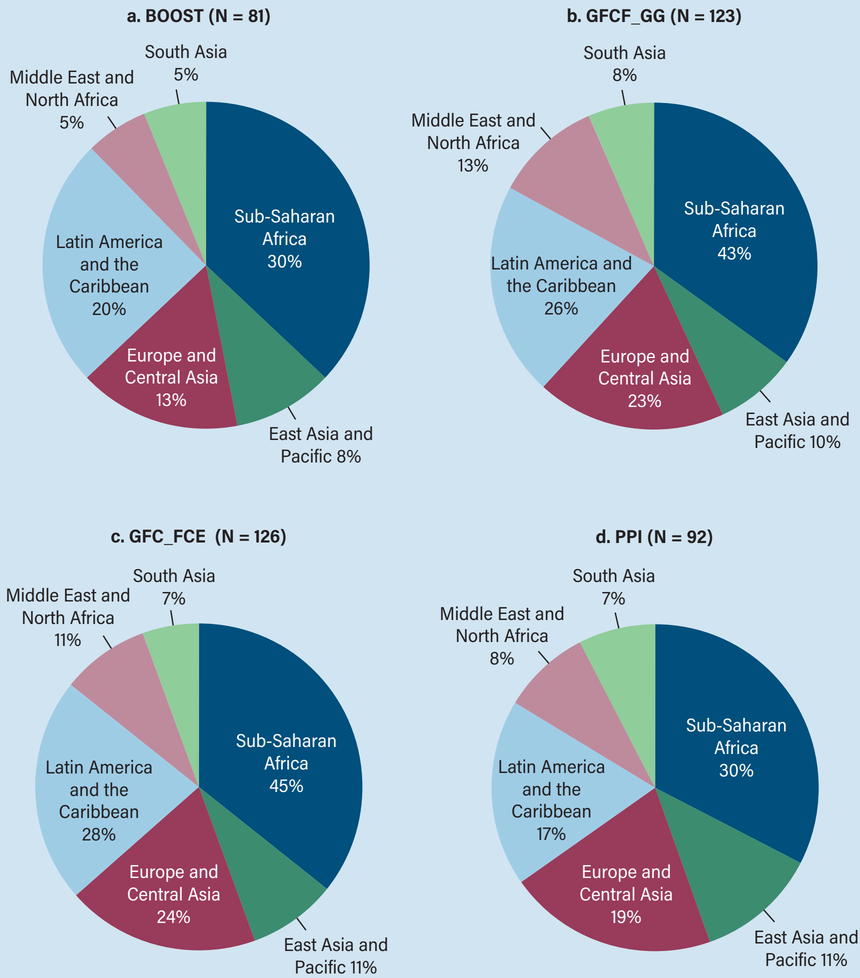
BOX 2.1.1 Quick Summary of the Four Datasets (*Continued*)

FIGURE B2.1.1.1 Estimation Methodologies: Number of Countries, by Region



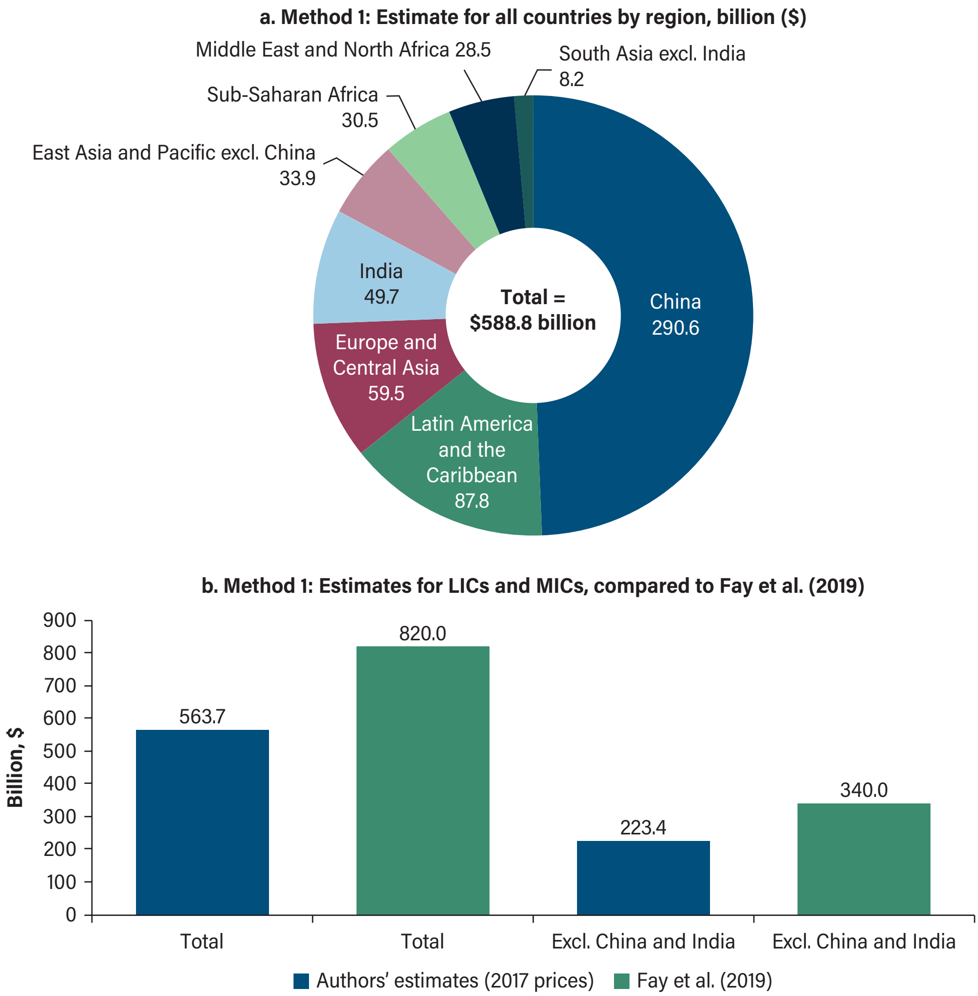
Source: Authors' elaboration.
Note: GFCF_GG = Gross Fixed Capital Formation of General Government; GFCF_CE = Gross Fixed Capital Formation on Civil Engineering Works; PPI = Private Participation in Infrastructure.

FOUR ESTIMATES OF GLOBAL INFRASTRUCTURE SPENDING

The estimate of total global infrastructure spending using this methodology provides a range of estimates following four different approaches. At the minimum, as shown by method one (figure 2.1.2), \$588.8 billion in 2017 constant prices was spent on capital expenditure on all infrastructure, of which China spent nearly half.

The capital expenditure in LICs and MICs constituted a large portion of this expenditure, at $563.7 billion in 2017 constant prices. This estimate is lower than the $820 billion estimated by Fay et al. (2019), though the regional patterns are similar. East Asia and Pacific (EAP) is still the highest spending region, at 2.19 percent of GDP, while Europe and Central Asia (ECA) and Middle East and North Africa (MENA) are the lowest, at about 1.37 percent of their GDP each.

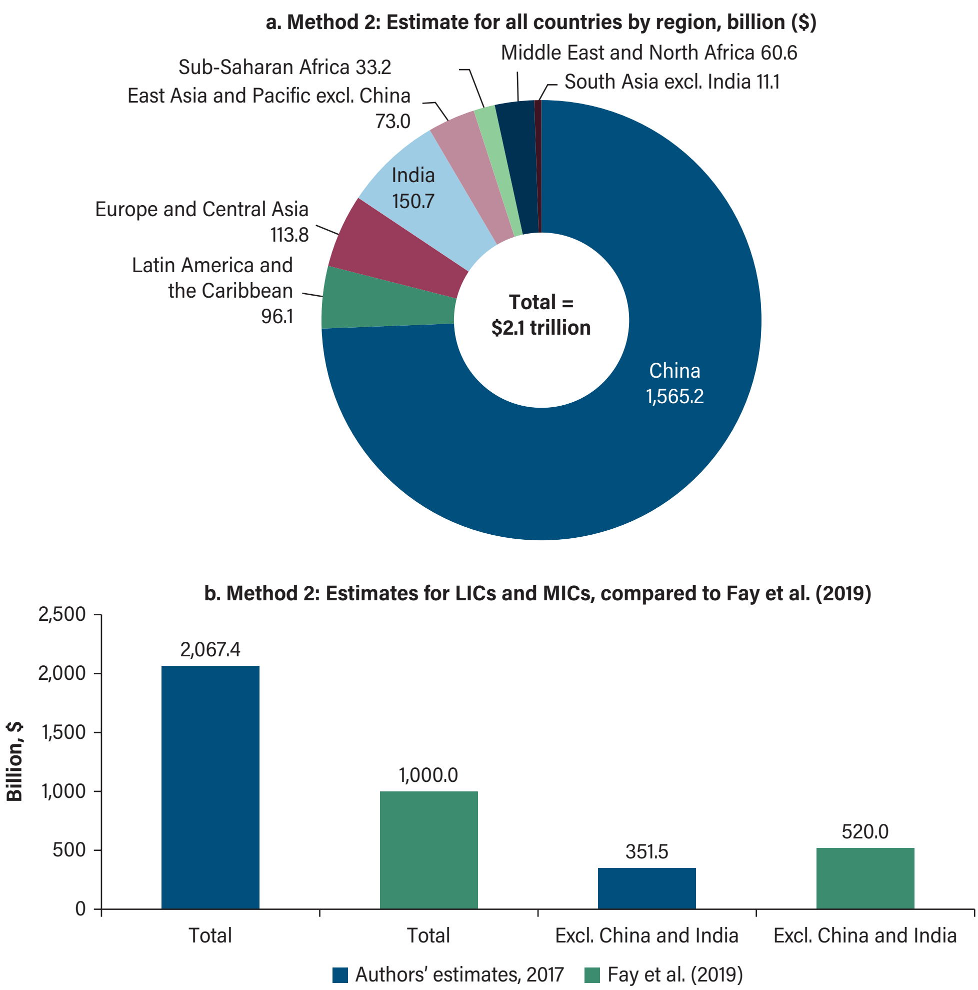
FIGURE 2.1.2 Method 1: $588.8 Billion was Spent Annually on Infrastructure Capital Alone; LICs and MICs, Including China, Spent at Least $563.7 Billion on Infrastructure Capital (2017 constant prices)



Source: Authors' estimation using BOOST and other relevant databases.
Note: These values are based on method 1 of IMF fitted values and actual BOOST + PPI. Estimates by Fay et al. (2019) excluding China only. PPI = private participation in infrastructure; LIC = low-income country; MIC = middle-income country.

Method two (intermediate estimate) (figure 2.1.3) uses BOOST and PPI data and supplements it by the minimum value of the two gross fixed capital formation (GFCF & GFCF_C) estimates when data are not available from BOOST. This results in an estimated $2.1 trillion infrastructure investment by LICs and MICs, compared to a $1 trillion estimate by Fay et al. (2019). Again, EAP spends the most (11.17 percent) while Sub-Saharan Africa (SSA) spends the least (2.04 percent).

FIGURE 2.1.3 Method 2: $2.1 Trillion was Spent Annually on Infrastructure Capital Alone; LICs and MICs, Including China, Spent at Least $2.07 Trillion on Infrastructure Capital (2017 constant prices)

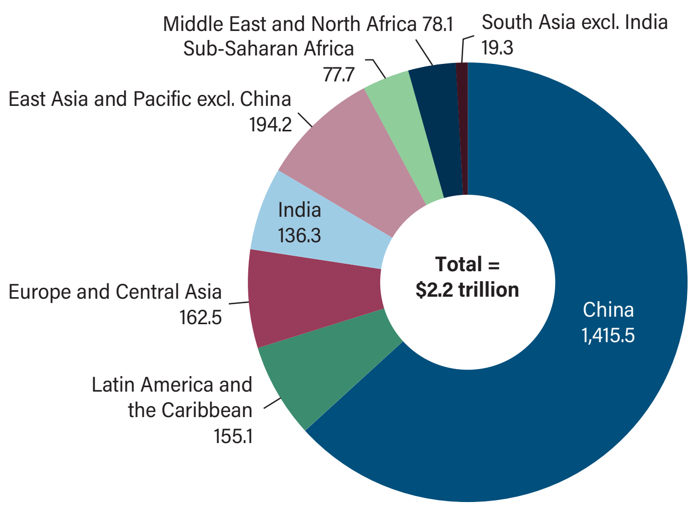


Source: Authors' estimation using BOOST and other relevant databases.
Note: These values are based on method 2, the middle estimate of BOOST or the lesser of two GFCFs. LIC = low-income country; MIC = middle-income country; GFCF = gross fixed capital formation.

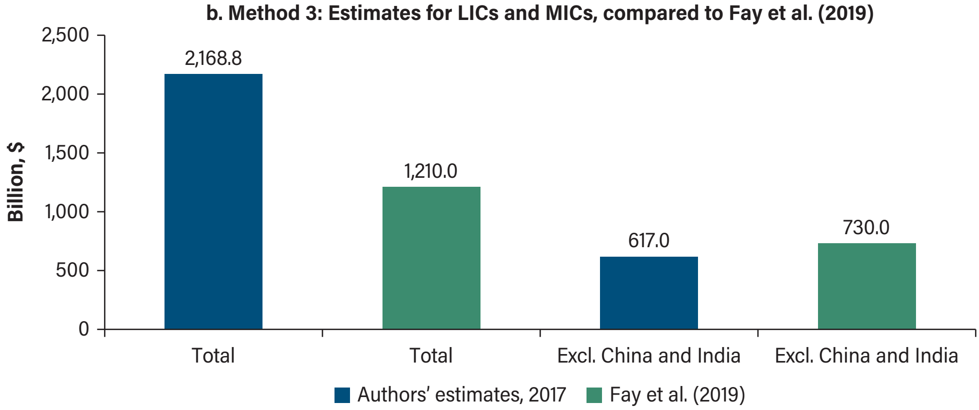
Method three (high estimate) (figure 2.1.4) uses only GFCF_CE and attempts to correct for the inclusion of non-infrastructure sectors (such as health and agricultural facilities) by reducing the GFCF_CE estimates by 10 percent. The 10 percent estimate of non-infrastructural expenditure is arrived at by using the BOOST data to identify non-infrastructure spending in GFCF_CE, such as spending on health or agriculture sectoral facilities. This estimates the infrastructure investment by LICs and MICs at \$2.2 trillion, compared to \$1.2 trillion by Fay et al. (2019). In this case, EAP also spends the most (10.9 percent), and Latin America and the Caribbean (LAC) spends the least (3.0 percent).

FIGURE 2.1.4 Method 3: \$2.2 Trillion Was Spent Annually on Infrastructure Capital Expenditure Alone; LICs and MICs, Including China, Spent at Least \$2.17 Trillion on Infrastructure Capital (2017 constant prices)

a. Method 3: Estimate for all countries by region, billion (\$)



b. Method 3: Estimates for LICs and MICs, compared to Fay et al. (2019)

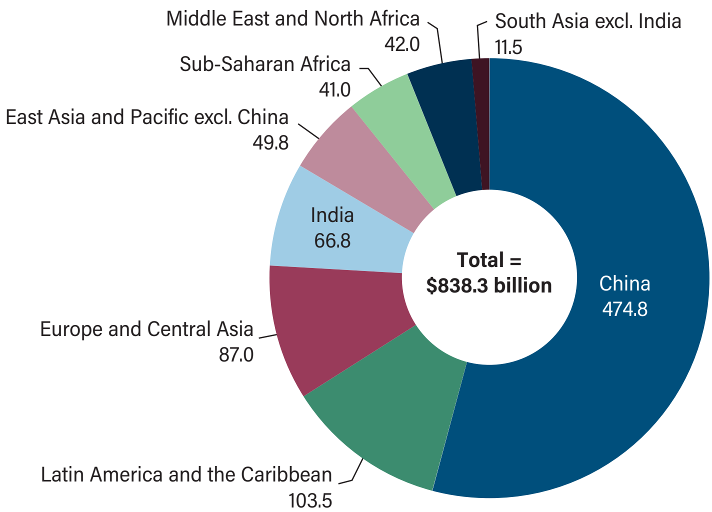


Source: Authors' estimation using BOOST and other relevant databases.
Note: These values are based on method 3, the upper-bound estimates of GFCF_CE multiplied by 0.9. LIC = low-income country; MIC = middle-income country; GFCF_CE = Gross Fixed Capital Formation on Civil Engineering Works.

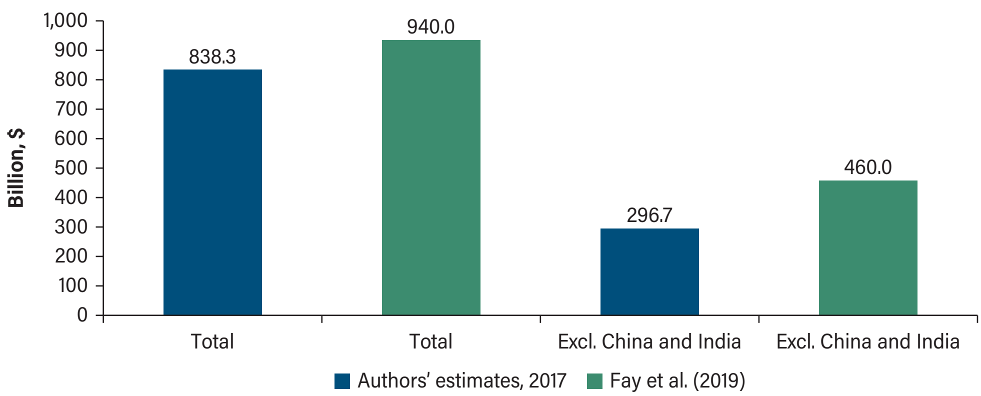
The fourth estimate, (figure 2.1.5) a refinement of method one, addresses the omission of SOE investments in BOOST by using the regional share of SOE investments from the SPI data. In most infrastructure sectors, SOEs carry out a considerable share of the service delivery and hence constitute a major share of investments. This results in an estimated infrastructure investment by LICs and MICs of $838.3 billion (from $563.7 billion in Method 1), compared to $940 billion by Fay et al. (2019). Again, EAP spends the most on infrastructure (3.55 percent), while ECA spends the least (2.00 percent) as a share of their GDP.

FIGURE 2.1.5 Method 1 Augmented with SOE: A Minimum of $876.3 Billion Was Spent Annually on Infrastructure Capital Expenditure, Including SOE Investments; LICs and MICs, Including China, Spent at Least $838.3 Billion on Infrastructure Capital (2017 constant prices)

a. Method 1: Augmented with SOE: Estimate for all countries by region, billion ($)



b. Method 1: Augmented with SOE: Estimates for LICs and MICs, compared to Fay et al. (2019)



Source: Authors' estimation using BOOST and other relevant databases.
Note: These values are based on method 4, using SOE-augmented BOOST and fitted values from the IMF. SOE = state owned enterprises; LIC = low-income country; MIC = middle-income country.

TABLE 2.1.1 Summary Estimates for Infrastructure Capital Spending, by Region, Income Group, and Methodology (share of GDP)

	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI) *N* = 130		Method 2 estimate: (BOOST + PPI or Minimum of two GFCFs) *N* = 137		Method 3 estimate: (0.9*GFCF_CE) *N* = 126		Method 1 Estimate: Refinement Augmented with SOE *N* = 130	
% GDP								
Region	Revised estimates	Fay et al. (2019)	Revised estimates	Fay et al. (2019)	Revised estimates	Fay et al. (2019)	Revised estimates	Fay et al. (2019)
Sub-Saharan Africa	1.89	1.91	2.04	2.56	4.78	3.47	2.55	2.39
East Asia and Pacific	2.19	5.36	11.07	5.72	10.89	6.72	3.55	5.61
Excluding China	1.37	1.78	2.93	3.51	7.87	8.24	2.01	2.98
Europe and Central Asia	1.37	1.53	2.55	2.74	3.71	4.36	2.00	2.18
Latin America and Caribbean	1.65	2.04	1.80	2.42	2.96	3.23	1.94	2.55
Middle East and North Africa	1.37	1.88	2.87	4.80	3.85	5.26	2.02	2.47
South Asia	1.73	3.67	4.83	4.49	4.68	4.26	2.34	4.73
Excluding India	1.18		1.59		2.85		1.64	
Total								
2017 $ billion								
High-income	25.1		36.3		70.0		38.1	
Low-income	7.2		7.6		23.1		9.9	
Lower-middle income	111.7		259.6		405.6		154.2	
Upper-middle income	444.8		1800.3		1740.1		674.1	
LICs and MICs, total	563.7	820.0	2067.4	1000.0	2168.8	1210.0	838.3	940.0
Global, total	223.4	340.0	351.5	520.0	617.0	730.0	296.7	460.0

Source: Authors' estimation using BOOST and other relevant databases.
Note: PPI = Private Participation in Infrastructure; GFCF = gross fixed capital formation; SOE = state owned enterprises; LIC = low-income country; MIC = middle-income country.

Estimating Water Sector Spending: Drilling Down

As demonstrated in the previous section, the range of estimates reported yields similar patterns and trends as the estimates by Fay et al. (2019). This study thus proceeds to the second step—that is, using overall infrastructure capital expenditure to model the capital expenditure for the water sector and the WSS subsector in 130 countries. To remain conservative, we prefer to use method one—the lower-level estimate of infrastructure capital spending as a share of GDP—as one of the predictors of water sector capital spending as a share of GDP. The four subsectors included are WSS, water transport, irrigation, and hydropower. The statistical methodology to estimate water sector public expenditure is elaborated on in box 2.1.2.

Nevertheless, we provide three levels of estimates of water sector capital spending: (i) a lower-bound estimate that includes only the government expenditure through the budget (both available and estimated from BOOST; (ii) a middle estimate, which augments the lower-bound estimate with private sector capital expenditure; and (iii) an upper-bound estimate, which refines the middle estimate to include

BOX 2.1.2 Statistical Approach to Estimating Water Public Expenditure

This analysis first estimates the infrastructure capital expenditure based on a regression analysis over a sample of 69 countries with common coverage among the BOOST database (as of October 2021) and the two estimates of GFCF_GG and GFCF_CE to estimate missing values for countries that are not covered by BOOST (Refinement 1).

Equation 1:

$$Infras_{capex} = \alpha + \beta_1 * GG + \beta_2 * CE + \beta_3 * \log GDP + \beta_4 * Federal + \varepsilon$$

where $Infras_{capex}$ is the BOOST estimate; *GG* and *CE* are estimates from GFCF_GG and GFCF_CE, respectively; log GDP is the logarithm of current GDP in 2017; and the dummy variable *Federal* identifies whether or not a country has a federal government system. Detailed descriptive statistics of input variables used in this study and in Fay et al. (2019), and regression results, are presented in appendix B. This approach allows the prediction of infrastructure capital expenditure in countries not covered by BOOST, resulting in the estimates for a total of 130 countries.

With the same model specification of equation 1, this analysis takes a further step to estimate capital expenditure in the water sector:

Equation 2: (out of sample prediction with regression over 69 BOOST observation for equations 2, 3, and 4, etc.)

$$Water_{capex} = \alpha + \beta_0 * Infras_{capex} + \beta_1 * GG + \beta_2 * CE + \beta_3 * \log GDP + \beta_4 * Federal + \varepsilon$$

This results in estimated water sector capital expenditures for 128 countries, with the out-of-sample prediction of infrastructure capital expenditure from equation 1. Using the water capital expenditure as an input, the total expenditure of the water sector is estimated next:

Equation 3:

$$Water_{tot\,exp} = \alpha + \beta_0 * Water_{capex} + \beta_1 * Federal + \beta_2 * X + \varepsilon$$

Covariates *X* includes income-level classifications and geographical regions. With the input variable of water capital expenditure, this analysis estimates the out-of-sample total expenditure based on

box continues next page

BOX 2.1.2 Statistical Approach to Estimating Water Public Expenditure (*Continued*)

the prediction from equation 2. For estimating the total public expenditure in the WSS, the same approach is employed as in the case of the water sector:

Equation 4:

$$WSS_{capex} = \alpha + \beta_0 * Water_{capex} + \beta_1 * GG + \beta_2 * CE + \beta_3 * \log GDP + \beta_4 * Federal + \varepsilon$$

Next, WSS capital expenditure is used as an input to estimate total expenditure in the WSS subsector:

Equation 5:

$$WSS_{tot\ exp} = \alpha + \beta_0 * WSS_{capex} + \beta_1 * Federal + \beta_2 * X + \varepsilon$$

Equations 4 and 5 provide the WSS subsector total and capital expenditure for 126 countries (both modeled estimates as well as actual BOOST data). Next, the total recurrent expenditure is calculated by subtracting capital expenditure from total expenditure for both the water sector as a whole and the WSS subsector. The above estimates are in 2017 constant prices.

the regional mean of SOE spending. Official Development Assistance (ODA) is not included in this calculation to avoid potential double counting because a significant portion of ODA is channeled to the public sector including central and local government recipients. It is unclear to what extent these funds are reflected in the government budget recorded by the BOOST database (see part 3 chapter 1).

ESTIMATING CAPITAL EXPENDITURE FOR THE WATER SECTOR AND WSS

Water Sector Capital Expenditure

The lower bound for the annual capital expenditures in the water sector is estimated to be about $114.5 billion in 2017 constant prices (figure 2.1.6). This value only includes public or government spending through budgetary allocations. The middle estimate, which includes private capital spending is estimated to be about $117.2 billion (excluding household spending). Finally, the upper bound, which includes spending by SOEs, is estimated to be $123.8 billion for the 130 countries included in the analysis. These values represent a range from 0.36 percent (lower bound) to 0.39 percent (upper bound) of the total GDP for the same countries in 2017 prices, with the middle estimate at about 0.37 percent.

Collectively, LICs and MICs spend between $107.0 billion (0.37 percent of GDP) and $115.4 billion (0.40 percent of GDP) annually on capital expenditures in the water sector in 2017 dollars. In contrast, countries in fragile, conflict and vulnerable contexts (FCV) spend a relatively smaller share of their GDP on capital expenditures in the water sector, estimated to be between $2.2 billion (0.19 percent) and $3.1 billion (0.27 percent) (see table 2.1.2). These estimated figures further underscore the financing and funding challenges faced by FCVs for their water sector's infrastructure development.

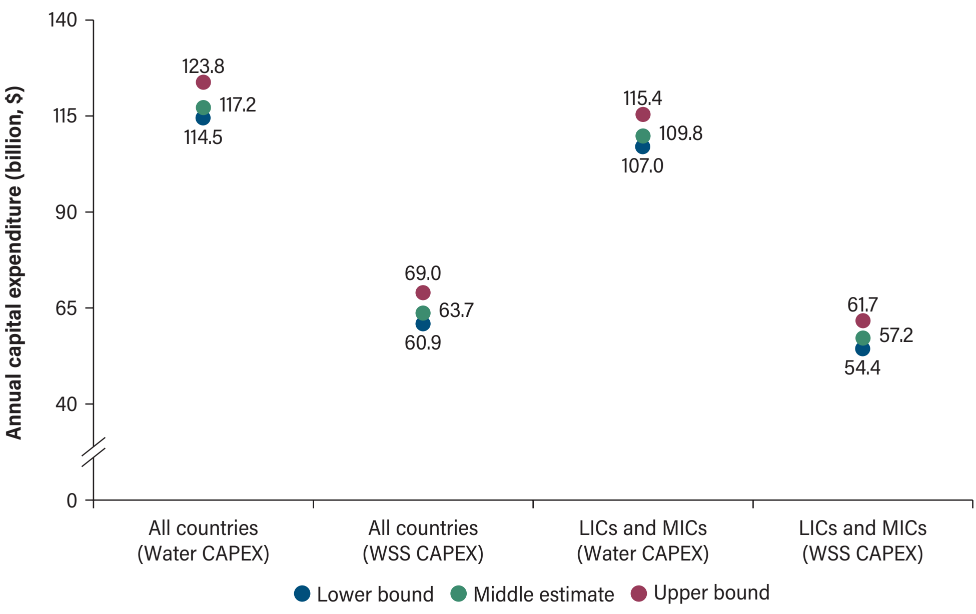
The lower bound for the annual capital expenditures in the water sector is estimated to be about $114.5 billion in 2017 constant prices.

Regionally, the majority of the annual water sector capital expenditure is attributed to EAP countries, including China, estimated to be between $81.3 billion (0.55 percent) and $82.3 billion (0.56 percent) (figure 2.1.7). At the end of spectrum, the SSA region appeared to have the lowest absolute annual capital spending, at around $3.8 billion to $6.9 billion in the water sector. It is also worth noting that, among all regions, ECA allocates the lowest share of its GDP to annual capital expenditure in the water sector.

WSS Capital Expenditure

Capital spending in WSS comprises a large portion of the water sector. Annual capital spending in WSS is estimated to be between $60.9 billion and $69.9 billion with a middle estimate of about $63.7 billion in 2017 prices (figure 2.1.6). The lower and upper bounds correspond to 0.19 percent and 0.22 percent of total GDP, respectively, with a middle estimate of 0.20 percent.

FIGURE 2.1.6 Estimated Annual Water Sector and WSS Capital Expenditure, by Country Groupings (2017 constant prices)

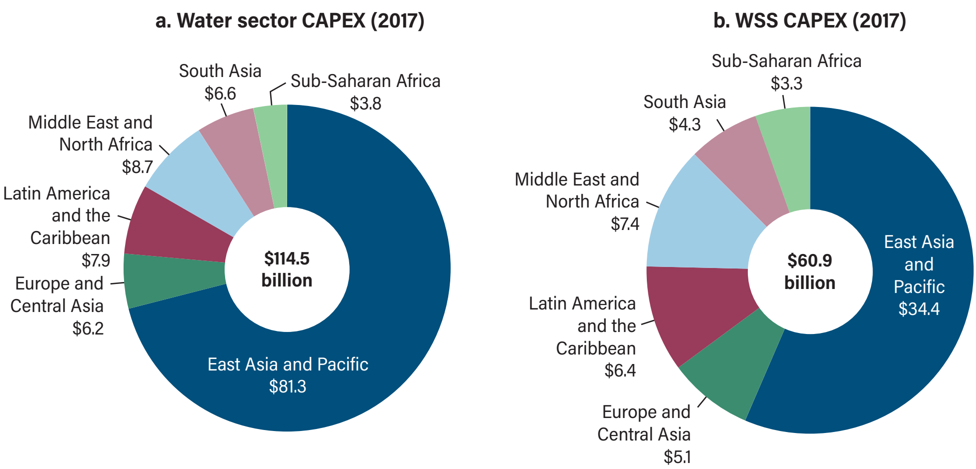


Source: Authors' estimation using BOOST database.
Note: Official development assistance is not included. CAPEX = capital expenditure; LIC = low-income country; middle-income country; WSS = water supply and sanitation.

LICs and MICs spent roughly between $54.4 billion (0.19 percent) and $61.7 billion (0.21 percent) annually while FCVs spent only about $1.4 billion (0.13 percent) to $2.2 billion (0.19 percent). Similar to the broader water sector trends, almost half of the estimated annual capital expenditures in WSS comes from the EAP region, totaling about $34.4 billion (0.23 percent) to $35.2 billion (0.24 percent) (figure 2.1.8).

Interestingly, as a share of its GDP, however, countries in the MENA region collectively spent about 0.35 percent to 0.42 percent (higher than that of the EAP) on annual capital spending in WSS. Finally, in absolute terms, annual capital expenditure in WSS is lowest in SSA. As a share of regional GDP, annual capital expenditure in WSS is lowest in ECA and LAC.

FIGURE 2.1.7 Estimated Water Sector and WSS Capital Expenditure (lower bound), by Region (2017 constant prices)



Source: Authors' estimation using BOOST database.
Note: CAPEX = captial expenditure; WSS = water supply and sanitation.

ESTIMATING TOTAL AND RECURRENT EXPENDITURE FOR THE WATER SECTOR

Total and Recurrent Expenditure for the Water Sector

In the following step, capital expenditure in the water sector is used as one of the key predictors to estimate the overall water sector expenditure.[3] Subsequently, recurrent expenditure in the water sector is calculated as the difference between total and capital expenditure. The estimated annual total spending in the water sector ranged from $140.7 billion (or 0.45 percent of the GDP) for the lower bound to $153.2 billion (0.49 percent) for the upper bound, in 2017 constant prices. The middle estimate for the total expenditure on water is $143.5 billion (0.46 percent) (figure 2.1.8 and figure 2.1.9).

Consequently, the sector's annual recurrent expenditure was estimated to be $26.2 billion for the lower bound, $26.3 billion for the middle estimate, and $29.4 billion for the upper bound (figure 2.1.10). This implies that a substantial portion of the water sector's budget is allocated to capital expenditures, which is not surprising, given the infrastructure-intensive nature of the sector.

Meanwhile, LICs and MICs collectively spend between $128.6 billion (0.44 percent) and $139.6 (0.48 percent) billion annually on the water sector, with corresponding recurrent expenditures of between $21.6 billion and $24.2 billion.

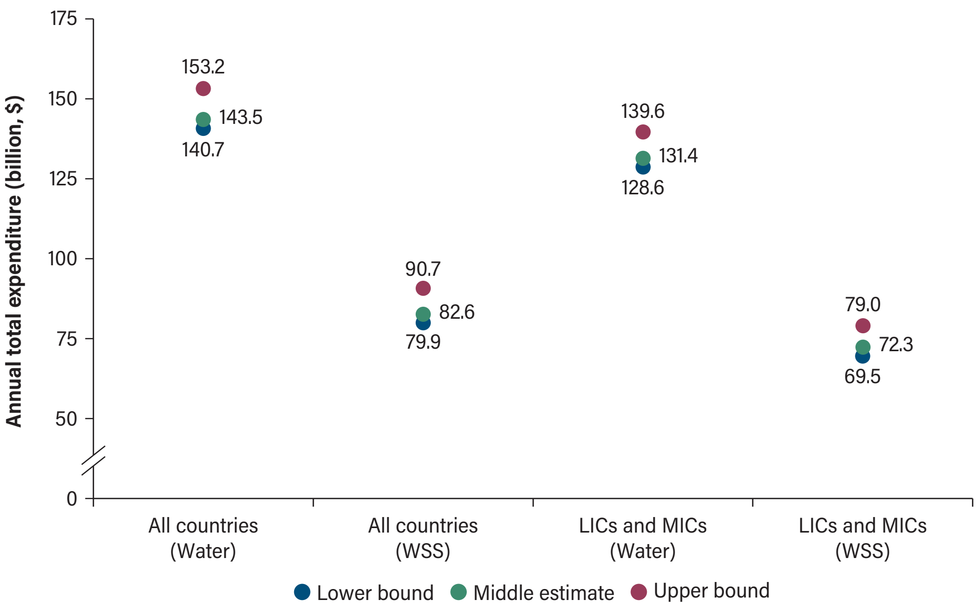
Conversely, FCVs spend only between $2.8 billion (0.24 percent) and $3.9 billion (0.42 percent) annually in the water sector, with between $0.6 billion and $0.8 billion on recurrent expenditures.

Similar to the findings on annual capital expenditures, in absolute terms EAP, including China, spent the most on the water sector on an annual basis, ranging from $90.9 billion (0.61 percent) to $91.9 billion (0.62 percent) (figure 2.1.11). On the other hand, SSA countries collectively spent the least in absolute terms on the water sector, estimated to be between $5.2 billion (0.32 percent) and $9.3 billion (0.58 percent). It is interesting to note, however, that the significant difference between the lower-bound and upper-bound estimates for total water sector spending in the region is primarily due to substantial spending by SOEs. Among all regions, SA spent the least share of its GDP in the water sector annually.

Total and Recurrent Expenditure for WSS

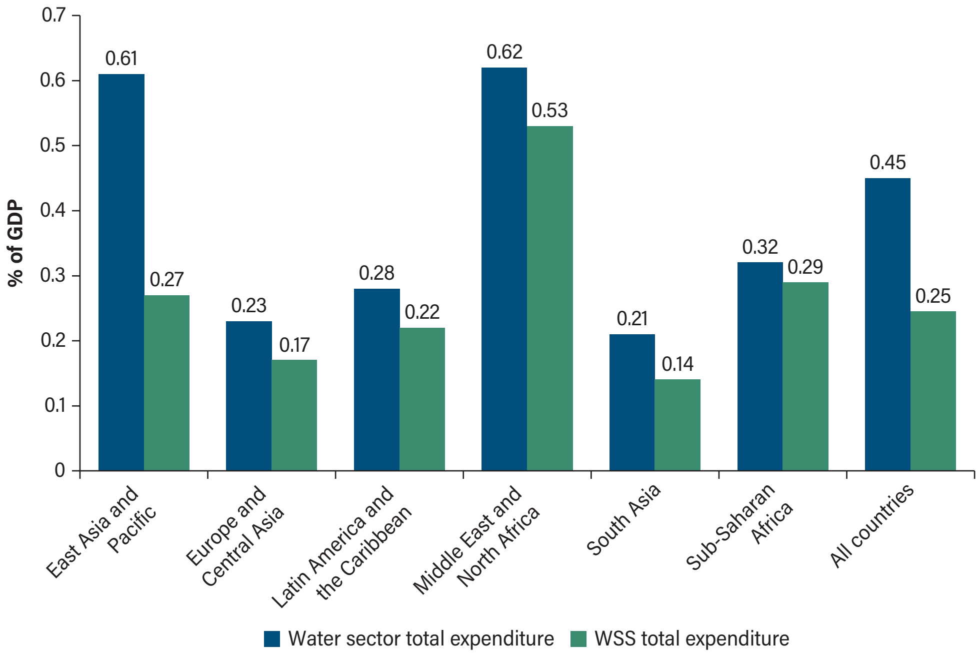
Similarly, total expenditure for WSS is estimated to be between $79.9 billion and $90.7 billion annually, with a middle estimate of $82.6 billion (figure 2.1.8 and figure 2.1.9). These figures also correspond to between $19.0 billion and $21.7 billion in annual recurrent spending, with a middle estimate of $18.9 billion (figure 2.1.10). This indicates that roughly between 57 percent and 59 percent of total water sector expenditure is directed toward the WSS subsector alone, making it the largest recipient of spending among water subsectors.

FIGURE 2.1.8 Estimated Water Sector and WSS Total Expenditure for All Countries and LICs and MICs (2017 constant prices)



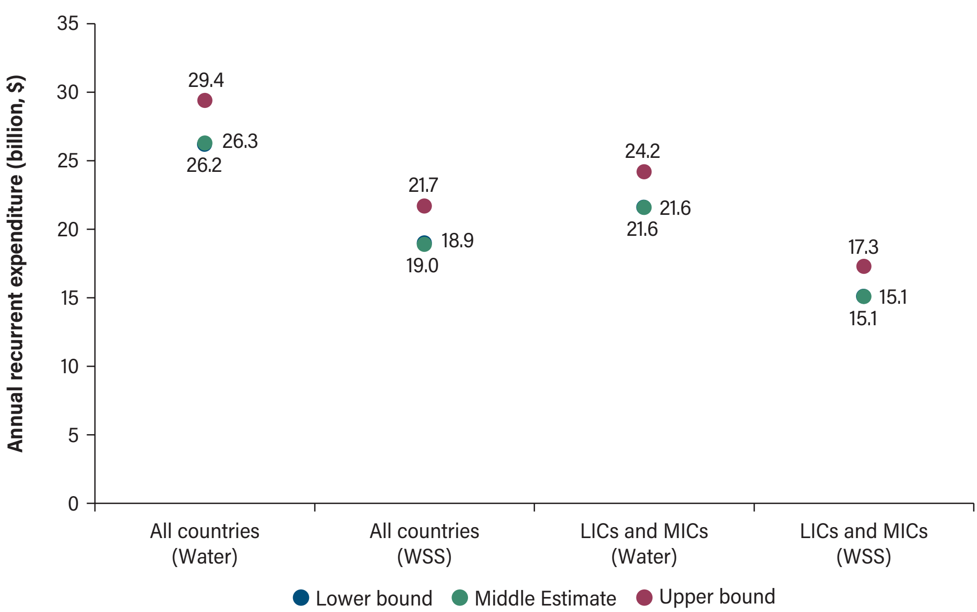
Source: Authors' estimation using BOOST database.
Note: Official development assistance is not included. LIC = low-income country; MIC = middle-income country; WSS = water supply and sanitation.

FIGURE 2.1.9 Total Expenditure in Water Sector and WSS as Share of GDP



Source: Authors' estimation using BOOST database.
Note: Official development assistance is not included. GDP = gross domestic product.

FIGURE 2.1.10 Estimated Water Sector and WSS Recurrent Expenditure for All Countries and LICs and MICs (2017 constant prices)

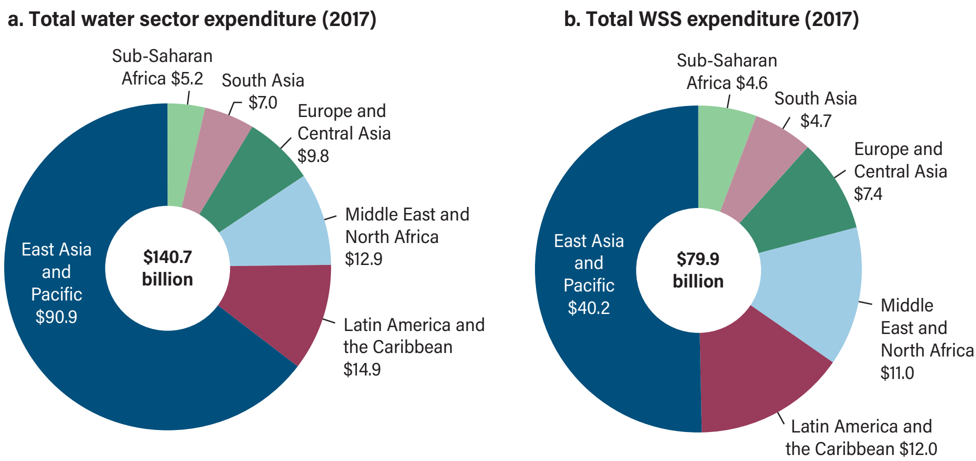


Source: Authors' estimation using BOOST database.
Note: Official development assistance is not included. LIC = low-income country; MIC = middle-income country; WSS = water supply and sanitation.

The average public spending on water as a share of country GDP is 0.42 percent, although the median is lower, at 0.36 percent.

Likewise, LICs and MICs spend between $69.5 billion (0.24 percent) and $79.0 billion (0.27 percent) annually in WSS, along with recurrent expenditures of $15.1 billion to $17.3 billion. On the other hand, FCVs dedicate only $1.8 billion (0.24 percent) to $2.7 billion (0.42 percent) to WSS, $0.4 billion to $0.5 billion of which is recurrent expenditures. Once again, the EAP region leads in absolute annual WSS spending, estimated to be around $40.2 billion to $41.0 billion (figure 2.1.11). Yet it is the MENA region which actually invests the most in WSS as a share of its regional GDP, ranging from 0.53 percent to 0.62 percent. Lastly, the SA region contributes the least to WSS in terms of regional GDP share.

FIGURE 2.1.11 Estimated Total Water Sector and WSS Expenditure (lower bound), by Region (2017 constant prices)

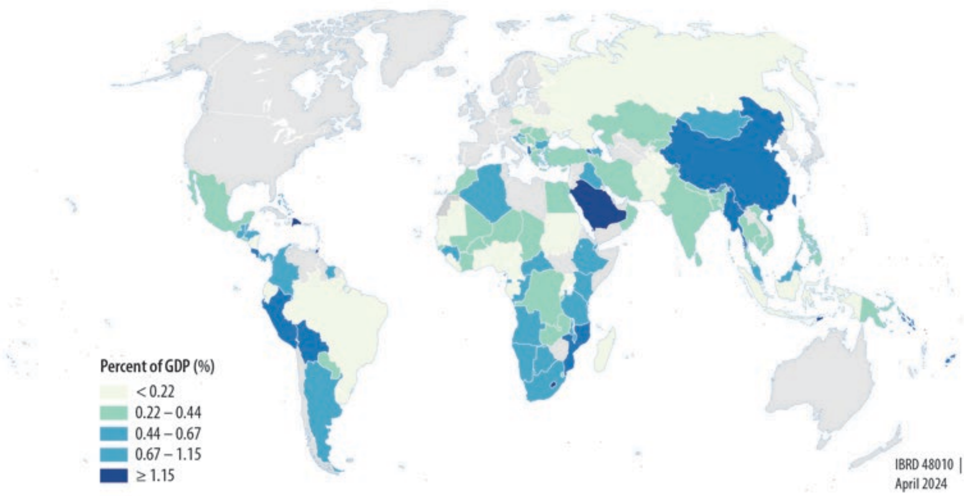


Source: Authors' estimation using BOOST database.
Note: WSS = water supply and sanitation.

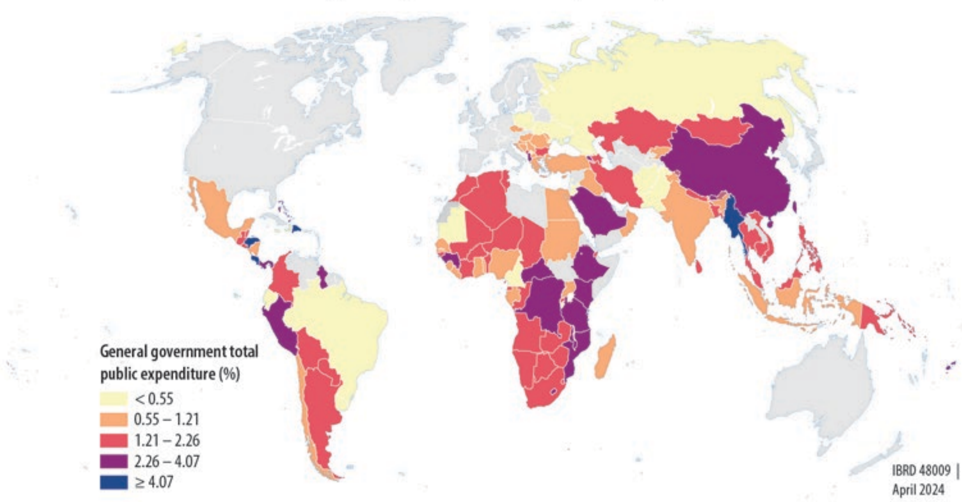
Map 2.1.1 shows a disaggregation of these expenditures by country, as a share of GDP and then as a share of total public expenditure, for 128 and 127 countries, respectively. The average public spending on water as a share of country GDP is 0.42 percent, although the median is lower, at 0.36 percent. Details on country-specific shares are presented in table appendix 2.1.a table 3. In general, the two maps are similar, showing that countries with a high share of water sector expenditure in total public expenditure also have high expenditure as a share of GDP.

MAP 2.1.1 Total Spending in Water Sector as a Share of GDP and as a Share of Total Public Expenditure

a. Share of GDP



b. Share of general government total public expenditure



Source: Author's estimation using BOOST database.

Public Spending in Irrigation

CAPITAL EXPENDITURE IN IRRIGATION

Information on public expenditure on irrigation is available only for a subset of countries, comprising a smaller set of the 130 countries covered in the preceding sections. Specifically, data on capital expenditures are available for 32 countries in the BOOST database, which limits the robustness of any further model-based predictions (table 2.1.5). For these countries, the estimated annual capital expenditures by government entities amount to $1.75 billion, representing 0.04 percent of total GDP in 2017 constant prices (table 2.1.5). Regionally, the EAP (0.26 percent) leads in capital expenditure on the irrigation subsector as a share of GDP, followed by ECA (0.11 percent).

TOTAL EXPENDITURE IN IRRIGATION

Information on total expenditures in the irrigation subsector is available for 41 countries (table 2.1.5). In these countries, annual capital expenditures by government entities are estimated to be $2.33 billion, accounting for 0.05 percent of total GDP in 2017 constant prices. It can therefore be inferred that a significant portion of public spending in the irrigation subsector constitutes capital expenditure.

Regionally, the EAP again emerges as the top spender on an annual basis in the irrigation subsector as a share of GDP (0.38 percent), followed by ECA (0.10 percent). Similar to the capital expenditure described above, only a single estimate is provided because spending information in the subsector was not available for SOEs and the private sector. Additionally, because of the limited availability of reliable public spending data for the irrigation subsector in a small number of countries, we have not provided multiple estimates of public spending, as we did for the WSS subsector (as well as for the water sector) in preceding sections. In part 2 chapter 2, the estimation of spending gaps in the irrigation subsector will be based on the data from these 41 countries.

SUMMARY TABLES

TABLE 2.1.2 Estimated Total, Capital and Recurrent Expenditures in the Water Sector and WSS in 2017 prices (Billion, $)

	Water Sector									Water Supply and Sanitation Subsector (WSS)								
	Total Expenditures			Capital Expenditures			Recurrent Expenditures			Total Expenditures			Capital Expenditures			Recurrent Expenditures		
	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound
Billion ($)																		
Regions																		
East Asia and Pacific	$90.9	$91.5	$91.9	$81.3	$81.9	$82.3	$9.6	$9.6	$9.6	$40.2	$40.8	$41.0	$34.4	$35.0	$35.2	$5.8	$5.8	$5.8
Europe and Central Asia	$9.8	$10.0	$10.4	$6.2	$6.3	$6.6	$3.6	$3.7	$3.8	$7.4	$7.6	$7.8	$5.1	$5.3	$5.5	$2.3	$2.3	$2.3
Latin America and the Caribbean	$14.9	$16.6	$19.4	$7.9	$9.6	$11.1	$7.0	$7.0	$8.3	$12.0	$13.6	$15.9	$6.4	$8.1	$9.3	$5.6	$5.5	$6.6
Middle East and North Africa	$12.9	$13.1	$15.0	$8.7	$9.0	$10.2	$4.2	$4.1	$4.8	$11.0	$11.3	$12.9	$7.4	$7.6	$8.7	$3.6	$3.7	$4.2
South Asia	$7.0	$7.0	$7.2	$6.6	$6.6	$6.7	$0.4	$0.4	$0.5	$4.7	$4.7	$4.8	$4.3	$4.3	$4.4	$0.4	$0.4	$0.4
Sub-Saharan Africa	$5.2	$5.2	$9.3	$3.8	$3.9	$6.9	$1.4	$1.3	$2.4	$4.6	$4.6	$8.2	$3.3	$3.3	$6.0	$1.3	$1.3	$2.2
Income Groups																		
Low income	$1.1	$1.1	$1.9	$0.8	$0.8	$1.5	$0.3	$0.3	$0.4	$0.8	$0.8	$1.4	$0.6	$0.6	$1.0	$0.2	$0.2	$0.4
Lower middle	$17.2	$17.5	$19.9	$13.6	$13.9	$15.7	$3.6	$3.6	$4.2	$12.1	$12.4	$14.4	$9.2	$9.5	$11.0	$2.9	$2.9	$3.4
Upper middle	$110.4	$112.8	$117.8	$92.6	$95.0	$98.1	$17.8	$17.8	$19.7	$56.7	$59.2	$63.2	$44.6	$47.1	$49.7	$12.1	$12.1	$13.5
High income	$12.1	$12.1	$13.7	$7.4	$7.4	$8.4	$4.7	$4.7	$5.3	$10.3	$10.3	$11.7	$6.4	$6.4	$7.3	$3.9	$3.9	$4.4
FCVs	$2.8	$2.8	$3.9	$2.2	$2.2	$3.1	$0.6	$0.6	$0.8	$1.8	$1.8	$2.7	$1.4	$1.5	$2.2	$0.4	$0.3	$0.5
LICs and MICs	$128.6	$131.4	$139.6	$107.0	$109.8	$115.4	$21.6	$21.6	$24.2	$69.5	$72.3	$79.0	$54.4	$57.2	$61.7	$15.1	$15.1	$17.3
All Countries	$140.7	$143.5	$153.2	$114.5	$117.2	$123.8	$26.2	$26.3	$29.4	$79.9	$82.6	$90.7	$60.9	$63.7	$69.0	$19.0	$18.9	$21.7

Source: Authors' estimation using BOOST database.
Note: Official development assistance is not included.

TABLE 2.1.3 Estimated Total, Capital and Recurrent Expenditures in the Water Sector and WSS in 2017 Prices (Share of GDP)

	Water Sector									Water Supply and Sanitation Subsector (WSS)								
	Total Expenditures			Capital Expenditures			Recurrent Expenditures			Total Expenditures			Capital Expenditures			Recurrent Expenditures		
	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound
% GDP																		
Regions																		
East Asia and Pacific	0.61	0.62	0.62	0.55	0.55	0.56	0.06	0.07	0.06	0.27	0.28	0.28	0.23	0.24	0.24	0.04	0.04	0.04
Europe and Central Asia	0.23	0.23	0.24	0.14	0.15	0.15	0.09	0.08	0.09	0.17	0.17	0.18	0.12	0.12	0.13	0.05	0.05	0.05
Latin America and the Caribbean	0.28	0.31	0.36	0.15	0.18	0.21	0.13	0.13	0.15	0.22	0.26	0.30	0.12	0.15	0.17	0.10	0.11	0.13
Middle East and North Africa	0.62	0.63	0.72	0.42	0.43	0.49	0.20	0.20	0.23	0.53	0.54	0.62	0.35	0.37	0.42	0.18	0.17	0.20
South Asia	0.21	0.21	0.21	0.20	0.20	0.20	0.01	0.01	0.01	0.14	0.14	0.14	0.13	0.13	0.13	0.01	0.01	0.01
Sub-Saharan Africa	0.32	0.33	0.58	0.24	0.24	0.43	0.08	0.09	0.15	0.29	0.29	0.51	0.21	0.21	0.37	0.08	0.08	0.14
Income Groups																		
Low income	0.31	0.31	0.55	0.25	0.25	0.44	0.06	0.06	0.11	0.23	0.23	0.40	0.17	0.17	0.31	0.06	0.06	0.09
Lower middle	0.24	0.25	0.28	0.19	0.20	0.22	0.05	0.05	0.06	0.17	0.17	0.20	0.13	0.13	0.15	0.04	0.04	0.05
Upper middle	0.51	0.52	0.54	0.43	0.44	0.45	0.08	0.08	0.09	0.26	0.27	0.29	0.21	0.22	0.23	0.05	0.05	0.06
High income	0.52	0.52	0.58	0.32	0.32	0.36	0.20	0.20	0.22	0.44	0.44	0.50	0.28	0.28	0.31	0.16	0.16	0.19
FCVs	0.24	0.24	0.34	0.19	0.19	0.27	0.05	0.05	0.07	0.16	0.16	0.24	0.13	0.13	0.19	0.03	0.03	0.05
LICs and MICs	0.44	0.45	0.48	0.37	0.38	0.40	0.07	0.07	0.08	0.24	0.25	0.27	0.19	0.20	0.21	0.05	0.05	0.06
All Countries	0.45	0.46	0.49	0.36	0.37	0.39	0.09	0.09	0.10	0.25	0.26	0.29	0.19	0.20	0.22	0.06	0.06	0.07

Source: Authors' estimation using BOOST database.
Note: ODA is not included.

TABLE 2.1.4 Estimated Total, Capital and Recurrent Expenditures in the Water Sector and WSS in 2017 Prices (Share of Total Public Expenditures)

	Water Sector									Water Supply and Sanitation Subsector (WSS)								
	Total Expenditures			Capital Expenditures			Recurrent Expenditures			Total Expenditures			Capital Expenditures			Recurrent Expenditures		
	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound	Lower Bound	Middle Estimate	Upper Bound
% Total Public Expenditures																		
Regions																		
East Asia and Pacific	2.29	2.31	2.32	2.05	2.07	2.08	0.24	0.24	0.24	1.01	1.03	1.03	0.87	0.88	0.89	0.15	0.15	0.15
Europe and Central Asia	0.61	0.62	0.64	0.38	0.39	0.41	0.22	0.23	0.24	0.46	0.47	0.48	0.32	0.33	0.34	0.14	0.14	0.14
Latin America and the Caribbean	0.88	0.98	1.14	0.47	0.57	0.65	0.41	0.41	0.49	0.71	0.80	0.94	0.38	0.48	0.55	0.33	0.32	0.39
Middle East and North Africa	1.95	1.98	2.27	1.32	1.36	1.54	0.64	0.62	0.73	1.67	1.71	1.95	1.12	1.15	1.32	0.55	0.56	0.64
South Asia	0.82	0.82	0.85	0.78	0.78	0.79	0.05	0.05	0.06	0.55	0.55	0.56	0.50	0.50	0.52	0.05	0.05	0.05
Sub-Saharan Africa	1.50	1.50	2.68	1.10	1.13	1.99	0.40	0.38	0.69	1.33	1.33	2.37	0.95	0.95	1.73	0.38	0.38	0.63
Income Groups																		
Low income	1.76	1.76	3.04	1.28	1.28	2.40	0.48	0.48	0.64	1.28	1.28	2.24	0.96	0.96	1.60	0.32	0.32	0.64
Lower middle	1.02	1.04	1.18	0.81	0.82	0.93	0.21	0.21	0.25	0.72	0.74	0.85	0.55	0.56	0.65	0.17	0.17	0.20
Upper middle	1.70	1.74	1.82	1.43	1.46	1.51	0.27	0.27	0.30	0.87	0.91	0.97	0.69	0.73	0.77	0.19	0.19	0.21
High income	1.35	1.35	1.53	0.83	0.83	0.94	0.52	0.52	0.59	1.15	1.15	1.30	0.71	0.71	0.81	0.43	0.43	0.49
FCVs	0.99	0.99	1.38	0.78	0.78	1.09	0.21	0.21	0.28	0.64	0.64	0.95	0.49	0.53	0.78	0.14	0.11	0.18
LICs and MICs	1.56	1.60	1.69	1.30	1.33	1.40	0.26	0.26	0.29	0.84	0.88	0.96	0.66	0.69	0.75	0.18	0.18	0.21
All Countries	1.54	1.57	1.68	1.25	1.28	1.36	0.29	0.29	0.32	0.87	0.90	0.99	0.67	0.70	0.76	0.21	0.21	0.24

Source: Authors' elaboration using BOOST database.
Note: ODA is not included.

TABLE 2.1.5 Estimated Total and Capital Expenditures in Irrigation in 2017 prices (share of GDP)

Region	GDP (Billion, $)	Capital expenditures (*N*=32) (Billion, $)	Share of GDP
Sub-Saharan Africa	$310.9	$0.26	0.08%
South Asia	$575.6	$0.09	0.02%
Europe and Central Asia	$51.1	$0.05	0.11%
Middle East and North Africa	$134.4	$0.09	0.06%
East Asia and Pacific	$72.5	$0.19	0.26%
Latin America and the Caribbean	$3,539.0	$1.07	0.03%
All countries (N=32)	$4,683.5	$1.75	0.04%
Region	**GDP (Billion, $)**	**Total expenditures (N=41) (Billion, $)**	**Share of GDP**
Sub-Saharan Africa	$371.9	$0.32	0.09%
South Asia	$580.4	$0.13	0.02%
Europe and Central Asia	$116.2	$0.12	0.10%
Middle East and North Africa	$134.4	$0.09	0.06%
East Asia and Pacific	$75.6	$0.29	0.38%
Latin America and the Caribbean	$3,543.7	$1.39	0.04%
All countries (N=41)	$4,822.2	$2.34	0.05%

Source: Authors' elaboration using BOOST database.
Note: Official development assistance is not included.

Water Sector Spending and Human Development Outcomes

WATER'S VITAL LINKS TO MANY SUSTAINABLE DEVELOPMENT GOALS

An integrated approach to water resources management needs to be guided by the recognition that water is intrinsically linked to many other economic sectors and can therefore have significant impacts on related development outcomes. In fact, besides SDG 6, which directly pertains to the water sector, spending in the sector can also promote SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Wellbeing), and SDG 5 (Gender Equality).

For example, food security (SDG 2) and the water sector are closely connected through the management of irrigation systems. Well-functioning irrigation systems provide a reliable source of water for crops, reduce the risk of crop failure due to droughts or inadequate rainfall, and increase agricultural productivity, making farmers more resilient in the face of climate change uncertainties.

Second, improving access to adequate, affordable, safely managed WASH facilities can promote better health (SDG 3) by reducing the burden of diseases arising from poor water and sanitation services. This is especially important in LICs and MICs where most of the sanitation-related disease burden, especially childhood undernutrition, falls on vulnerable communities. Additionally, increasing access to water and sanitation services can help reduce poverty (SDG 1) by reducing the burden of water collection on women and girls, freeing up their time for education and other productive activities (SDG 5). In summary, many human development and poverty-related challenges faced by developing countries are closely tied to the availability or lack of water.

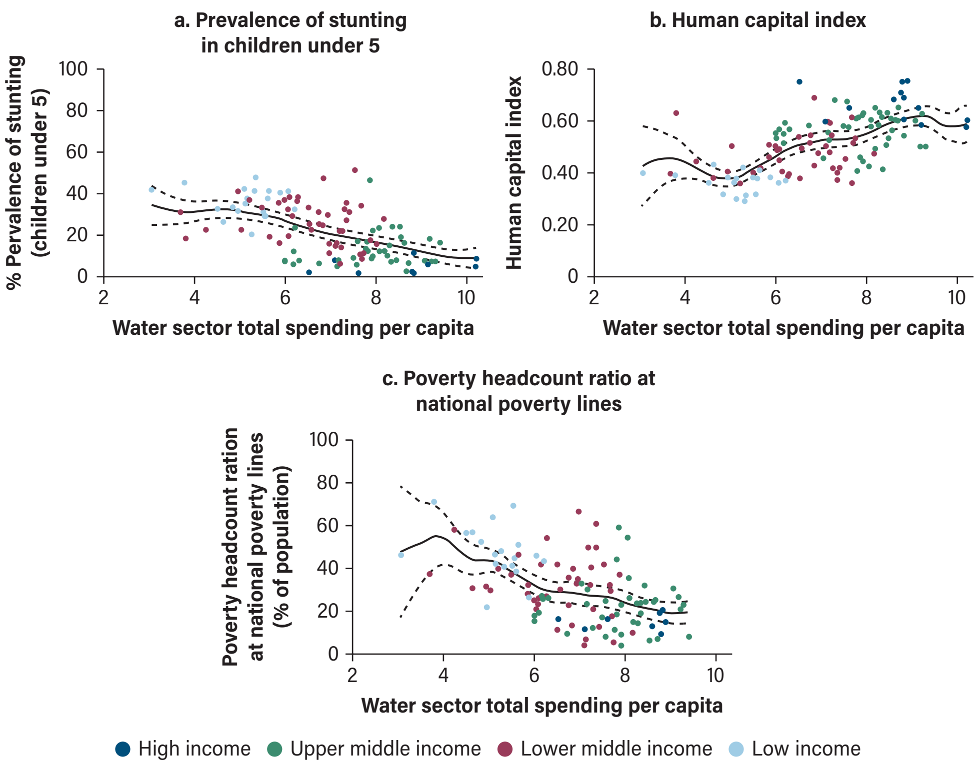
WATER'S PARTICULAR ROLE IN NUTRITION AND UNDERNUTRITION

Water plays an integral role in many of the determinants of undernutrition. Inadequate access to the right kinds of nutrition can result in stunting, particularly among young children—an indicator of undernutrition.[4] UNICEF's three-part framework for nutrition is based on the role played by environmental health, food security, and pre- and post-natal care in child nutrition, especially in the first 1,000 days of life (Cuesta and Maratou-Kolias 2017).[5] Water relates to this framework along all three dimensions: (i) In the area of environmental health, water plays a vital role in maintaining good hygiene and health by preventing the spread of infectious diseases, which can hinder a child's ability to utilize nutrients for healthy development; (ii) in the area of food security, water availability impacts agricultural production and therefore access to nutrients by influencing dietary diversity for better or for worse; and (iii) in pre- and post-natal care, the availability of clean water and sanitation facilities in health facilities, before, during, and after delivery markedly affects the health outcomes of newborns (Chase et al. 2019).

As illustrated by the pathways described above, spending levels in the water sector can impact nutrition outcomes such as stunting. This is important because stunted children are less likely to achieve not only their full physical stature but also their cognitive potential as adults, which can have lifelong implications for their welfare, job prospects, and the overall state of human capital in their country. To quantify the contribution of education and health to the productivity of a country's next generation of workers (Kraay 2018), the World Bank's Human Capital Project combines into a single index five measures of human capital: Probability of survival to age 5, expected years of school, harmonized test scores, fraction of children under 5 not stunted, and fraction of 15-year-olds surviving to age 60. WSS services improve all five indicators, primarily through better health and a reduced disease burden. This link between water and human capital across a person's life cycle is well documented in other parts of the development literature (Andres et al. 2018; Damania et al. 2017; Shah and Steinberg 2017). For countries to achieve sustained and inclusive economic growth and hence reduce poverty, they must focus on achieving positive health outcomes and providing the right education for a workforce prepared for the highly skilled jobs of the future. This is unlikely to happen unless human capital and individual wellbeing are strengthened (World Bank 2019).

The following discussion explores the association between spending in the water sector and development outcomes. The panels in figure 2.1.12 present the results of this exercise using stunting, the human capital index, and poverty as development outcomes. The results show that spending in the water sector correlates with all the three selected human development outcomes. Each individual circle in these figures represents a country, with the different colors denoting different country income categories.

FIGURE 2.1.12 Correlations of Water Sector Spending per Capita with Human Development Outcomes, by Income Group



Source: Author's elaboration using BOOST database and World Bank Development Indicators (WDI).
Note: Water supply and sanitation total spending from BOOST and fitted values (in current $), and total spending per capita are transformed into natural logarithm.

With a few exceptions, higher- and upper-middle-income countries, represented by the green and blue circles, respectively, spend more on the water sector per capita than middle- or lower-income countries. However, regardless of the income bracket in which a country falls, stunting levels and water sector spending per capita are associated negatively. In other words, at every level of income, higher spending per capita on the water sector is positively associated (correlation coefficient of 0.59) with lower stunting.

Moreover, as expected, the level of human capital in a country, as measured by the human capital index, correlates positively with per capita spending on water, with a correlation coefficient of 0.65. Note that the positive association becomes apparent only after a certain minimum threshold spending per capita is achieved. Poverty and per capita water spending also have a negative correlation of 0.52, indicating that higher water spending and lower poverty rates are correlated. Disaggregating the spending on WSS yields similar results.

Discussion and Closing Remarks

This chapter has offered an estimation of the magnitude of aggregate public spending in the water sector for 130 countries globally. Annual public spending in the water sector is estimated to be $140.7 billion, corresponding to the lower bound. Total spending if the private sector were included—the middle estimate—would be $143.5 billion. Finally, if SOEs were also included—the upper bound—the annual spending in the water sector would be $153.2 billion in 2017 constant prices. These figures correspond to 0.45 percent, 0.46 percent, and 0.49 percent of GDP, respectively. Also, more than half of the total water sector spending is in the WSS subsector, estimated to be between $79.9 billion and $90.7 billion, or 0.25–0.29 percent of GDP.

On average, countries affected by fragility, conflict, and violence spend a relatively smaller share of their GDP annually in the water sector than the rest of the world, highlighting the financing and funding challenges they face in developing their water sectors.

In addition, capital expenditure constitutes a significant portion of total public spending in the water sector, accounting for over three-fourths of total expenditure in both the water sector and WSS subsector. Globally, capital expenditure in the water sector is estimated to range from $114.5 billion (0.36 percent) to $123.8 billion (0.39 percent). Meanwhile, annual capital spending for WSS is estimated to be between $60.9 billion (0.19 percent) and $69.0 billion (0.22 percent).

Low- and middle-income countries (LICs and MICs) spend between $128.6 billion (0.44 percent) and $139.6 billion (0.48 percent) annually in the water sector, with about $69.5 billion (0.24 percent) to $79.0 billion (0.27 percent) dedicated to WSS. Conversely, in 2017, FCVs spent only $2.8 billion (0.24 percent) to $3.9 billion (0.42 percent) on the water sector, with $0.6 billion to $0.8 billion on recurrent expenditures. FCVs, on average, seem to spend a relatively smaller share of their GDP annually in the water sector than the rest of the world, highlighting the financing and funding challenges FCVs face in developing their water sectors.

The East Asia and Pacific region, including China, spends the most on the water sector and WSS subsector in absolute terms. Yet, in terms of regional GDP share, it was MENA which actually invested the most in WSS. Conversely, in absolute terms, SSA spends the least in both the water sector and WSS.

As explained at the beginning of this chapter, public spending was estimated by employing a "whole-of-water" approach that encompasses a range of subsectors such as WSS, irrigation, water transport, and hydropower. This approach is crucial because of the fragmented nature of the sector, which is typically administered by multiple departments, ministries, and agencies. A lack of coordination and communication among these entities has posed challenges in developing an integrated development plan with a clear investment roadmap. By examining public spending in the water sector holistically, knowledge gaps can be bridged, potential synergies can be explored, and tradeoffs among the different subsectors can be identified.

It is important to acknowledge certain limitations in the estimations presented in this chapter. Table 2.1.1 demonstrates that the estimated lower bound for capital spending in infrastructure sectors in this study is smaller than previous estimations by Fay et al. (2019), while the upper-bound estimation is larger. This disparity may arise from differences among the countries included in the analysis (see table G.1). Nevertheless, the patterns in infrastructure sector capital spending across different regions remain consistent. For instance, both in this study and in Fay et al. (2019), the EAP region spends the most on infrastructure as a share of regional GDP, while ECA and the MENA spend the least. Another potential limitation is that the underlying databases, such as the BOOST and GFCF databases, undergo periodic adjustments and revisions: this study uses the latest versions available as of the time of the study.

Lastly, the "whole-of-water" or integrated approach to water management recognizes the intrinsic linkages between water, its various subsectors, and other economic sectors. Consequently, spending in the water sector can have significant impacts on development outcomes that go beyond SDG 6, the "clean water and sanitation for all" goal. It can also contribute to other SDGs such as SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Wellbeing), and SDG 5 (Gender Equality).

The later parts of this chapter demonstrate that per capita spending in the water sector correlates with a lower prevalence of poverty and stunting among young children as well as a higher human capital index, even when country income categories are accounted and controlled for. By recognizing the interconnections between water and these important development outcomes, policymakers can leverage targeted investments to foster sustainable development. A unified and comprehensive approach to water management is essential for maximizing the sector's potential and realizing broad socioeconomic benefits.

Notes

1. COP stands for Conference of the Parties to the United Nations Framework Convention on Climate Change. It is an annual climate change summit now in its 28th year. COP28 will be held in Dubai from November 30 to December 12, 2023.
2. Estimates of actual spending are the basis for calculating the spending gap in part 2 chapter 2 of this study.
3. See appendices A and B for a detailed description of the methodology.

4. Stunting is defined as height-for-age that is more than two standard deviations below the WHO Child Growth Standards median (WHO 2015).
5. The first 1,000 days of life is the period from conception to roughly a child's second birthday. It is considered a critical window of opportunity for the child's growth and development. The brain and body develop rapidly, and the events and experiences of this period can have a profound lifelong impact on the child's cognitive, physical, and social-emotional development and, hence his or her health, education, and economic outcomes. Adequate nutrition, starting during pregnancy, is a critical component of the child's development during this period. It promotes healthy growth and reduces the risk of malnutrition and stunting.

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CHAPTER 2.2

Mind the Gap

KEY MESSAGES

- Although the Sustainable Development Goals (SDGs) were universally adopted in 2015[1]—almost a decade ago—the world has made insufficient progress toward achieving the targets of SDG 6, which commits governments to ensure access to clean water and sanitation for all, and of SDG 2, which aims to end hunger and promote sustainable agriculture.
- The slow progress may reflect spending levels that are too low.
- Although past attempts have been made to estimate *global* "spending gaps" for water supply and sanitation (WSS) and for irrigation, those efforts have not considered current and past fiscal spending patterns, focusing instead on just spending requirements.
- Overall, countries are not spending enough to achieve SDG targets 6.1 and 6.2 (universal safely managed water supply and sanitation services) by 2030. The annual spending gap to achieve the targets is an estimated $131.4 billion–140.8 billion in 2017 constant prices, or 0.45–0.48 percent of the overall GDP of the 113 countries analyzed.
- To meet the SDG targets, annual spending on the WSS subsector will, on average, need to increase to at least 2.7 times its current level, but between 9.5 to 17.0 times in SSA.
- Regionally, Sub-Saharan Africa (SSA) and South Asia (SA) have the largest spending gaps, but almost 35 percent of the total spending gap comes from fragile, conflict-affected, and vulnerable (FCV) countries. FCVs will need to increase their annual spending to between 19.0 and 28.5 times the current level, and low income countries (LICs) between 23.7 and 42.3 times, to bridge their gaps.
- Achieving universal access to basic water, sanitation, and hygiene (WASH) services by 2030 may be a more realistic target than SDGs 6.1 and 6.2. Globally, with India and China included, the world is experiencing a spending surplus to achieve this target.
- In irrigation, countries are not spending enough to even achieve the low-cost target; the overall annual spending gap, between 2015 and 2030, is $3.5 billion in 2017 constant prices.
- The spending gaps are likely to be underestimate as they do not account for (i) the effects of climate change in raising the future costs of providing WSS and irrigation services or accessing bulk water, (ii) the cost of insuring infrastructure against climate disasters, nor (iii) the higher cost of last-mile-service delivery to hard-to-reach or remote populations.

- With its numerous links to other development sectors, sluggish progress in the water sector could profoundly impact the progress for virtually all the other SDGs, including reducing poverty, improving public health, and combating climate change. This makes it imperative to fully understand these spending gaps.

The Importance of Spending Gaps in the Water Sector

WATER IS CLOSELY TIED TO MANY DEVELOPMENT OUTCOMES

Because the water sector interlinks with many others, progress or delays in this sector can significantly impact many other development goals, particularly those related to the SDGs. Access to safe, reliable water is considered a basic human right and a prerequisite to healthy living. It is also a critical resource for agricultural production, industrial processes, and energy generation. Despite the effort of many governments and development partners in the last decade to extend the coverage of water infrastructure and services, many countries still face significant challenges in providing their populations with safe, reliable water and sanitation.

Insufficient spending on water infrastructure can have significant consequences for communities and individuals, particularly those living in marginalized or under-resourced areas. For example, poorly functioning irrigation systems can lead to crop failure because of unreliable water availability, increasing the risks of food insecurity (SDG 2), especially in communities that heavily depend on local production as the primary source of food and employment. Inadequate access to safely managed WASH services can increase the risk of diarrheal disease transmission, resulting in the undernutrition and stunting of young children (Prüss-Ustün et al. 2019; Wolf et al. 2014, 2023). In summary, many development challenges faced by developing countries are closely tied to water, emphasizing the importance of bridging the sector's spending gaps to achieve a more sustainable future.

SLACK PROGRESS TOWARD THE SDG WATER-RELATED TARGETS

SDGs 6.1 and 6.2 and Water Supply and Sanitation (WSS)

Although the SDGs were universally adopted in 2015, the world has not made enough progress toward achieving the targets set out in Goal 6. SDG 6 aims to ensure the availability and sustainable management of safe WASH services for all by 2030. According to Joint Monitoring Programme (JMP) data, the global community is not on track to realizing universal and equitable access to safe and affordable drinking water (target 6.1) nor to achieving adequate and equitable sanitation and hygiene for all (target 6.2).

Achieving these targets by 2030 will require at least quadrupling the current rate of progress[2] in safely managed WASH services (WHO and UNICEF 2021, 2023). As of 2022, only 32 countries were on track to gaining universal access to safely managed water, and only 17 countries were on track to achieving universal safely managed sanitation services by 2030.[3] This means that, globally, more than a quarter of the world's population—almost 2.2 billion people—lack access to safely managed water, and 3.5 billion lack access to safely managed sanitation services in 2022. Many of them live in low-income countries (LICs) (WHO and UNICEF 2021, 2023). These statistics not only highlight the pressing need to accelerate progress in the water sector to meet the SDGs by 2030, but also point to policy weaknesses that have resulted in spending levels insufficient to engender that progress.

Spending or investments in WSS are critical not only to achieving SDG 6.1 and 6.2 but also to improving health and human capital development outcomes. In many development contexts, safely managed WASH facilities play a decisive role in shaping public health and nutrition outcomes. In 2019, nearly 1,035,000 deaths and the loss of 54.6 million disability-adjusted life years (DALYs)[4] caused by diarrhea were attributable to inadequate WASH services (Wolf et al. 2023). Among children under five, almost 273,000 diarrhea-related deaths in 2019 can be attributed to poor WASH services (Wolf et al. 2023).

To put this more starkly: As a result of unsafe water and sanitation services, one child under the age of five dies about every 100 seconds round the clock. It is estimated that 69 percent of diarrheal cases, 14 percent of acute respiratory infections, 10 percent of undernutrition, and essentially 100 percent of the burden of soil-transmitted helminthiasis could have been prevented with safe WASH (Wolf et al. 2023).

In addition, young children exposed to poor sanitation are at greater risk of malnutrition and stunting because of diminished gut function (that is, environmental enteropathy), caused by repeated diarrheal infections, that undermines their ability to absorb essential nutrients (Humphrey 2009). Malnutrition and stunting during early childhood, particularly between conception and age two, can have lasting effects on later-life outcomes such as adult health, education attainment, cognitive ability, and economic potential, all of which are crucial components of human capital development formation (Case and Paxson 2010; Dewey and Begum 2011; Glewwe, Jacoby, and King 2001; Spears and Lamba 2016). In addition to gastrointestinal diseases, WASH—especially proper handwashing and hygienic facilities including antibacterial soap—plays a crucial role in preventing the spread of respiratory illnesses. It is why handwashing was advanced the most important prevention measure during the COVID-19 pandemic[5] (Alzyood et al. 2020; Yang 2020; Joseph et al. 2023). Finally, emerging research examining household water insecurity points to its implications for not only physical but also mental health, such as psychosocial stress and lower cognitive function (Jepson et al. 2017; Wutich 2020; Young et al. 2019).

Inadequate access to WASH also affects other aspects of public health and livelihood, especially for women and young girls in rural communities. The burden placed on women and girls by poor or inadequate WASH is multifaceted. Many of their socially defined, gender-based domestic roles revolve around water use, and inadequate access to safely managed water supply services increases the time they must expend undertaking household and communal responsibilities. It often means that women and young children must travel farther to fetch water, sometimes hours a day. This not only demands physical and mental effort but makes them more vulnerable to physical injury, sexual and gender-based violence, and domestic violence (Gonsalves, Kaplan, and Paltiel 2015; Jadhav, Weitzman, and Smith-Greenaway 2016; Pommells et al. 2018; Tallman et al. 2022). For younger girls, especially those of school age, spending time fetching water can limit their time for studying and other productive activities (Dreibelbis et al. 2013; Hemson 2007; Nauges and Strand 2017).

The impact of inadequate WSS infrastructure and services extends beyond public health. Poor maintenance of water infrastructure leads to water shortages, which can cause businesses to lose sales where water is a key production input. This is particularly true for informal businesses, which are especially prevalent in developing countries and which tend to receive poor water service, including frequent shortages (Damania et al. 2017).

Additionally, greening investments in the water sector contribute to the global fight against climate change because proper water and sanitation management help reduce greenhouse gas (GHG) emissions. Wastewater treatment and discharge directly account for as much as 12 percent of global methane production (Giné-Garriga et al. 2023). Moreover, because water extraction, treatment, and distribution are energy-intensive, the WSS subsector consumes about 4 percent of global electricity, which contributes indirectly to carbon dioxide and other GHG emissions (Giné-Garriga et al. 2023). By 2030, the WSS subsector's energy consumption is expected to have increased by 50 percent, with the largest increase coming from desalination processes and large-scale water transfer (Giné-Garriga et al. 2023).[6]

The challenge of reaching SDG 6 is particularly daunting for LICs and FCVs. These countries not only have the lowest share of the population with access to safely managed WASH services but also face significant obstacles in extending those services to poor and vulnerable communities. As a result, many people are at risk of being left behind. To underscore the formidable challenge some countries face in attaining SDG 6.1 and 6.2: to achieve universal access to safely managed WASH services by 2030, countries, on average, need to increase their current rate of progress-not spending fourfold. However, LICs need to raise that rate 10 times higher than their current rates (WHO and UNICEF 2021).

SDG 2 and Irrigation

The global effort to fulfill SDG 2 (Zero Hunger) is also proving difficult. Despite the rising demand for food, investments in irrigation have not kept apace. As a result, between 2014 and 2019, the prevalence of undernourishment—a measure of the number of people suffering from hunger—did not decline in almost any region (FAO et al. 2021). Additionally, the current growth rate of the food supply is not keeping up with global population growth, resulting in less food available per capita and greater vulnerability to food insecurity in many development contexts (FAO et al. 2021). This has made it increasingly difficult to achieve SDG 2. Increasing investments in irrigation is crucial to bridging this gap.

Investing in irrigation infrastructure would help reduce the impact of water scarcity by replenishing rainfed croplands that are vulnerable to droughts with year-round water availability, thus enhancing agricultural productivity.

During the COVID-19 pandemic, food insecurity actually worsened. As more people became affected and/or were pushed into poverty, the prevalence of undernourishment rose from 8.4 percent in 2019 to about 9.9 percent in 2020—reversing almost a decade's progress (FAO et al. 2021; World Bank 2020). As a result in 2020, between 720 million and 811 million people, or one in ten people globally, faced hunger (FAO et al. 2021). The world already was not on track to achieving SDG 2 by 2030, but the coronavirus pandemic further exacerbated the hunger and food insecurity challenge.

The pandemic also exposed how vulnerable global food supply chains are, especially how easily severe simultaneous food shortages, insecurity, and hunger can erupt in many areas of the world. It led to a 3.7 percent increase in global consumer price inflation in 2021, the largest rise since the 2008 financial crisis. One lesson among others from this is the need for greater investment in irrigation, along with storage infrastructure, to increase the world's cultivable land area and agricultural productivity, particularly in countries with high untapped agricultural potential.

For example, while 23 percent of SSA's GDP comes from agriculture, its agricultural potential is far larger. Estimates suggest that if this potential were met, Africa would add 20 percent more cereals and grains to current global output (Goedde, Ooko-Ombaka, and Pais 2019).[7] Investing in irrigation and storage would help diversify the agricultural global supply chain, benefiting secondary producers and consumers while also reducing the impact of supply chain disruptions such as the ones during the recent pandemic.

Additionally, if climate change, as expected, becomes more severe, adversely impacting agricultural productivity, food insecurity and supply disruptions could worsen in the coming years. Climate change, it is predicted, will reduce freshwater resources, leading to water scarcity in many parts of the world (Jiménez Cisneros et al. 2014). Investing in irrigation infrastructure would help reduce the impact of water scarcity by replenishing rainfed croplands that are vulnerable to the droughts with year-round water availability, thus enhancing agricultural productivity. The potential for irrigation expansion is significant: in 2010, only about 43 percent of irrigable land was irrigated, and irrigated cropland makes up only 30 percent of global cropland (FAO 2017; Frenken 2012).

Estimating the Spending Gaps in WSS and Irrigation

The sluggish progress in both the WSS and irrigation subsectors toward their respective SDG targets indicates a need for more spending in the water sector. As discussed, because the water sector is intrinsically linked to many others, the rate of progress there can significantly impact other development challenges. It is therefore important to understand the financial outlays needed to achieve the sector's SDG targets and the actual spending in the sector. Although efforts have been made to estimate the required investments, they have not considered current and past fiscal spending patterns (Fox et al. 2019; Hutton and Varughese 2016, 2020). This chapter makes a significant contribution by providing estimates of spending gaps (required minus actual spending) in both subsectors.

The upcoming sections present the estimated annual spending requirements for WSS and irrigation to achieve the SDG targets, along with other relevant scenarios. Subsequently, this study, using findings from the preceding chapter, presents estimates of current spending in both subsectors. Lastly, estimates of the spending gap in both subsectors are presented. The WSS portion of the analysis in this chapter covers 113 countries, comprising low-income, lower-middle-income, and upper-middle-income countries in six World Bank regions—South Asia (SA), East Asia and Pacific (EAP), Middle East and North Africa (MENA), SSA, Europe and Central Asia (ECA), and Latin America and the Caribbean (LAC). These 113 countries represented 82 percent of the global population in 2021 and more than a third of the global GDP in 2017.

Estimated Spending Requirements

WATER AND SANITATION

The spending requirements of the WSS subsector depend on the type of water or sanitation infrastructure and the level of service that will be provided. The cost of constructing sanitation infrastructure and facilities varies widely across countries. The unit cost of sewage collection and treatment ranges from $100 in Guinea, Nepal, or Somalia to over $1,000 in Costa Rica, Papua New Guinea, or Sudan (Fox et al. 2019; Hutton and Varughese 2016). This variability is driven by the local cost for labor and materials, spending efficiency, and even the prevalence of corruption (Hutton and Varughese 2016).

The service level and intended extent of sanitation coverage also affect costs because they vary significantly. For instance, "safely managed drinking water services" are services that are accessible on premise, available when needed, and free from contamination. "Safely managed sanitation services" are improved facilities that are not shared and where fecal waste is either (i) treated and disposed of onsite, (ii) stored temporarily and then transported to be treated offsite, or (iii) transported through a sewer to be treated offsite. In short, safely managed WSS services are of higher quality, meet higher standards of safety, reliability, and accessibility, and are therefore costlier to provide than basic levels of service.

This chapter makes a significant contribution by providing estimates of spending gaps (required minus actual spending) in both subsectors.

The analysis of these spending requirements follows similar targets and estimates presented in previous studies

(Fox et al. 2019; Hutton and Varughese 2016, 2020). They are (i) universal access to basic WASH by 2030,[8] and (ii) universal access to safely managed WSS by 2030 or SDG 6.1 and 6.2. Table 2.2.1 summarizes the costs included in the two targets. The estimation of spending requirements includes all the resources required to install, operate, and maintain WASH services. It has three components: (i) capital expenditure costs, (ii) capital maintenance costs, and (iii) recurrent costs (Hutton and Varughese 2016). Capital costs, or CAPEX, includes planning and supervision, hardware, construction and house alteration, protection of water sources, education, and behavioral change.

Capital maintenance costs, on the other hand, include the maintenance of hardware, replacement of parts, and renovation or rehabilitation of hardware to extend its life. Recurrent or operating costs (OPEX) include the day-to-day materials needed to provide a service, regulation, ongoing protection, and monitoring of water sources, water treatment and distribution, and continuous education activities. These costs are adjusted to 2017 prices (Hutton and Varughese 2020).

TABLE 2.2.1 Comparing the Two WSS Targets Used in the Analysis

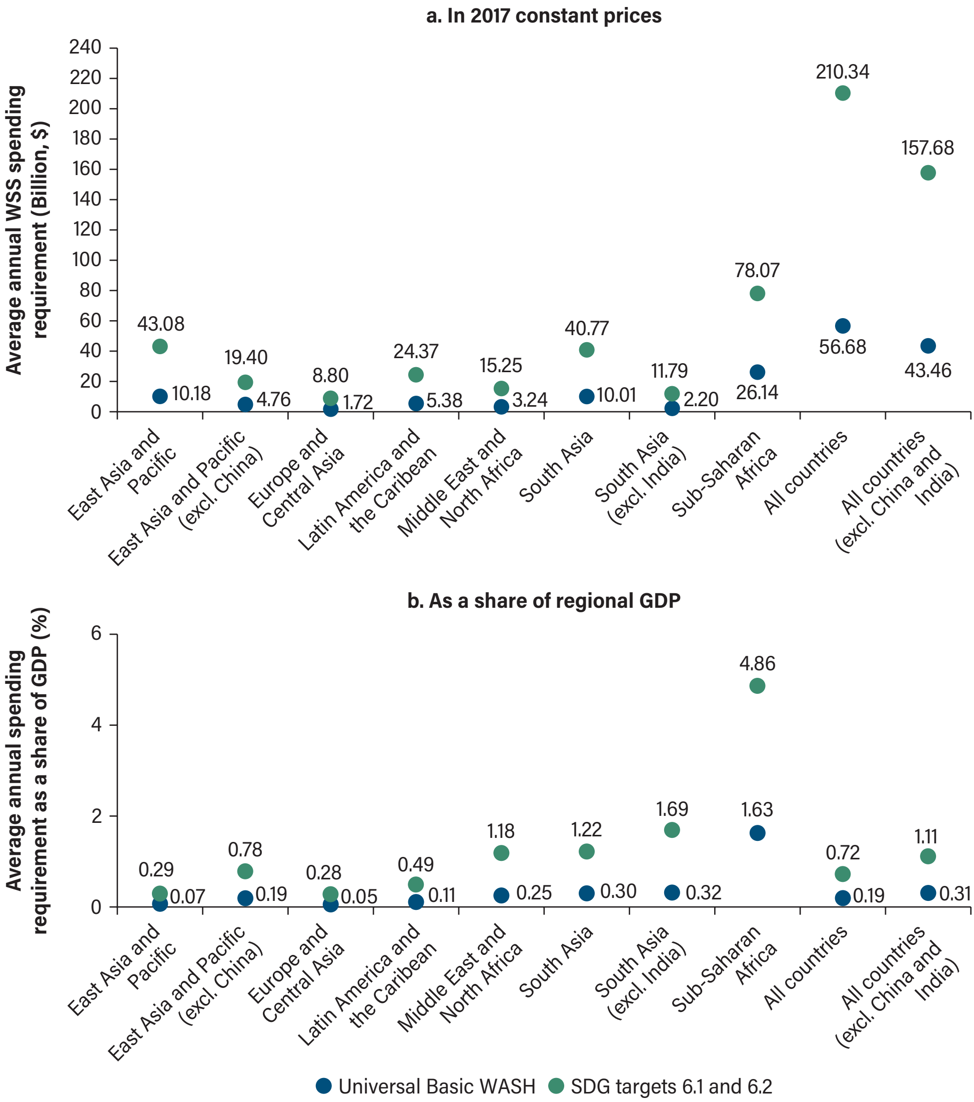
Targets	Definition	Intensity level
SDG targets 6.1 and 6.2 (universal access to safely managed WASH services by 2030)	Costs to achieve universal access to safely managed water (SDG 6.1); universal access to safely managed sanitation (SDG 6.2); universal access to basic hygiene, including a first-time cost to eradicate open defecation, with the assumption that there is a 50 percent stepwise transition from basic water to safely managed water services	More ambitious
Universal access to basic WASH services by 2030	Costs to achieve universal access to basic WASH services in all 113 countries, including a first-time cost to eradicate the practice of open defecation	More achievable

Note: SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene; WSS = water supply and sanitation.

The annual spending requirements to achieve SDGs 6.1 and 6.2 in the WSS subsector between 2017 and 2030 are estimated to be about $210.3 billion in 2017 constant prices, or 0.72 percent of total 2017 GDP. This estimate is based on the 113 countries, including China and India. If those two countries, which constitute a large share of the spending in the subsector, are excluded, the annual spending required falls to $157.7 billion, but rises as a share of GDP to about 1.11 percent. The $210.3 billion requirement represents roughly three times the estimated current annual public spending on WSS for the same 113 countries (see sections below). Figure 2.2.1 summarizes the estimated spending requirements by target and region.

Considering how ambitious these targets are, achieving universal access to basic WASH services by 2030 may be a more realistic and attainable goal (Fox et al. 2019; Rozenberg and Fay 2019). The spending requirement to achieve this is about $56.7 billion per year between 2017 and 2030—about 0.20 percent of overall GDP in 2017. If China and India are excluded, the adjusted spending requirement ($43.5 billion) widens to 0.31 percent of GDP. These figures also resonate with the finding of the JMP report that, as of 2020, 84 countries had achieved universal access to basic water services, and 62 had achieved universal basic sanitation services (WHO and UNICEF 2021).

FIGURE 2.2.1 Estimated Average Annual WSS Spending Requirements, by Target and Region, in 2017 Constant Prices and as a Share of GDP, 2017–30



Source: Authors' elaboration using data from Hutton and Varughese (2020).
Note: SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene; WSS = water supply and sanitation.

For both the ambitious and the more achievable levels of target, the spending requirements to achieve the target as a share of GDP are highest in SSA, followed by SA and LAC. The region with the lowest spending requirement as a share of its GDP is ECA. For SSA, it is estimated that as much as 1.63 percent of regional 2017 GDP ($26.1 billion) would be required every year between 2017 and 2030 merely to achieve universal access to basic WASH, while 4.86 percent ($78.1 billion) would be required to achieve SDG 6.1 and 6.2.

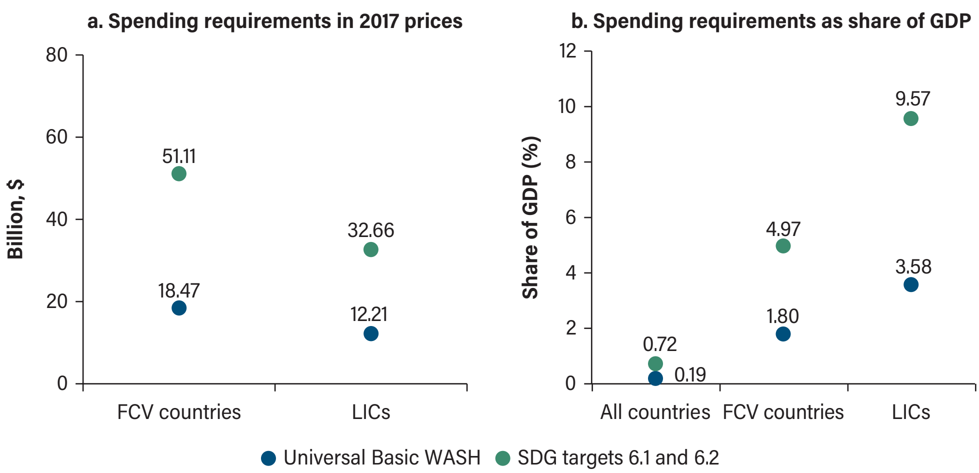
Still, the countries facing the most substantial annual spending requirements to achieve either target, expressed as a share of their GDP, are those situated in fragile, conflict-affected, and vulnerable (FCV) contexts, as well as low-income countries (LICs). To attain the SDG targets 6.1 and 6.2, FCVs will need to spend approximately 4.97 percent of their GDP within the WSS sector, while LICs will have to commit 9.57 percent of their GDP between 2017 and 2030. These figures represent nearly 7 and 13 times, respectively, the average GDP share for all 113 countries to meet the SDG targets (0.72 percent). Similarly, while the spending requirements to achieve universal basic WASH access are lower (more than halved) for FCV contexts (1.80 percent) and LICs (3.58 percent), they remain high compared to the overall average (0.19 percent) again.

The findings concerning FCV countries and LICs underscore the extreme lack of coverage in these countries. According to the JMP, people living in FCV contexts were twice as likely to lack safely managed drinking water services than those living in non-fragile contexts. Moreover, 8 out of 10 people who still lacked even basic services lived in rural areas, with roughly half of them living in least developed countries (LDCs) (WHO and UNICEF 2021).

The countries facing the most substantial annual spending requirements to achieve either target, expressed as a share of their GDP, are those situated in fragile, conflict-affected, and vulnerable contexts and low-income countries.

Overall, the FCV countries in our analysis include 23 of the 37 countries identified worldwide to be in FCV contexts in 2023, representing 81 percent of the population living in such contexts. Meanwhile, 21 of 27 LICs[9] in 2023 were included in our analysis, representing roughly 84 percent of the population living in LICs.

FIGURE 2.2.2 Estimated Average Annual Spending Requirements for WSS in FCV and Low-Income Countries, 2017–30, by Target



Source: Authors' elaboration using data from Hutton and Varughese (2020).
Note: FCV = fragile, conflict-affected, and vulnerable; LIC = low-income country; SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene.

IRRIGATION

Historically, the state has played a central role in the irrigation sector in most countries. In many countries, substantial government financial support is needed to construct extensive infrastructure such as storage systems and canals to replace traditional rainfed or flood-based methods because most private farmers lack the means. Even in high-income countries, government agencies or basin authorities often subsidize irrigation scheme capital costs, with OPEX costs borne by the end users (Fox et al. 2019). In contrast, in lower- and middle-income countries, government agencies and water user organizations typically subsidize not only CAPEX but also a portion of OPEX (Fox et al. 2019).

Apart from government support, other factors that affect the costs of spending or investments in irrigation systems include the availability of water, which can be influenced by climate variations and competition for water from other economic sectors, types of crops, cropping methods, and technology, and the competition for land. For example, agricultural expansion, both at the extensive and intensive margins, often creates substantial opportunity costs for other economic activities or environmental concerns.

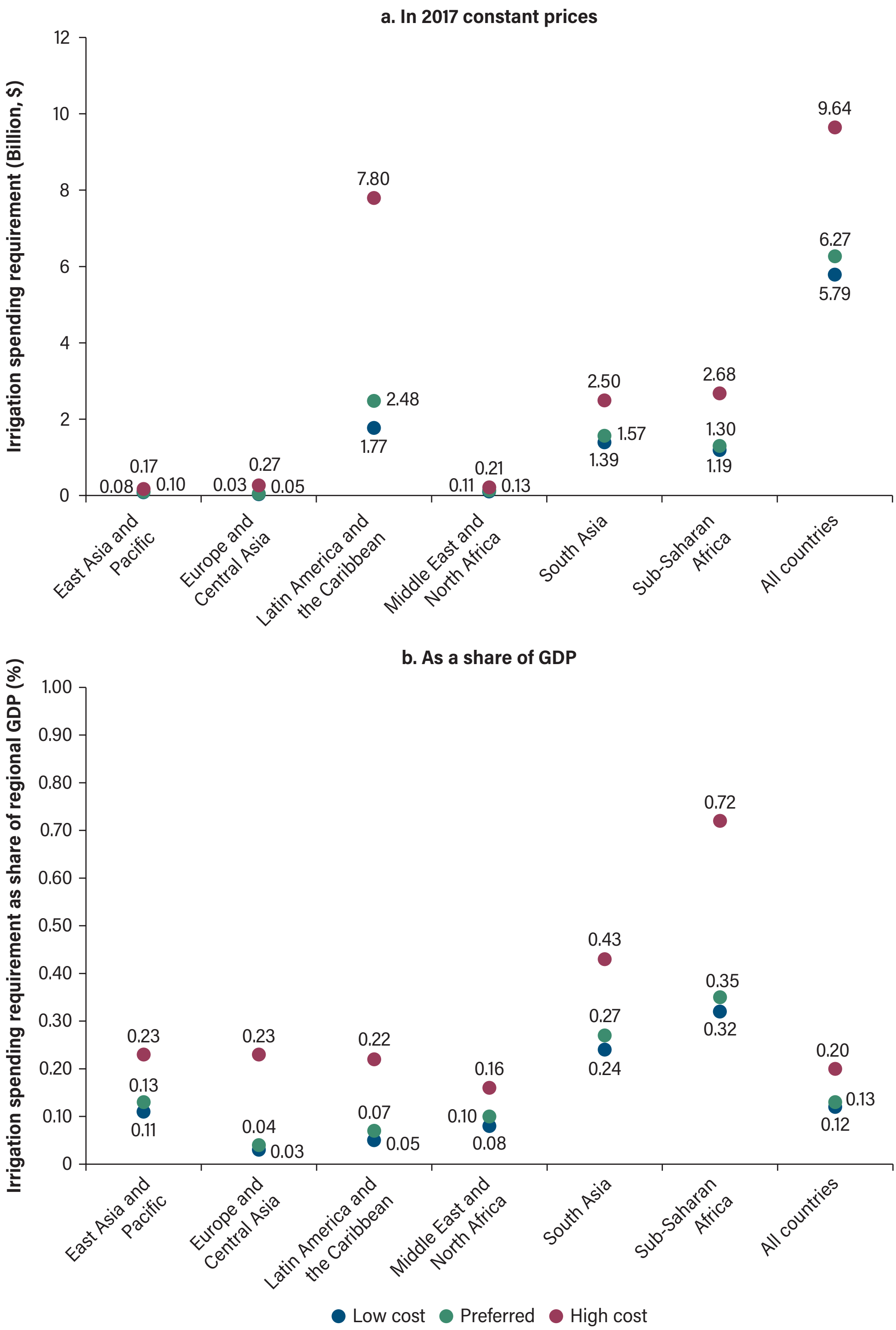
For this portion of the analysis, this study will use the estimated spending requirements for irrigation presented in Rozenberg and Fay (2019), adjusted for 2017 prices. The definitions of the three scenarios are presented in table 2.2.2.[10] The dollar value of the spending requirement in each World Bank region is computed by multiplying the share of irrigation spending requirement—obtained from Rozenberg and Fay (2019)—with the regional GDP based on the 41 countries included in this analysis.[11]

TABLE 2.2.2 Comparison of Three Irrigation Spending Requirement Scenarios

Scenario	Adopted definition
Low cost	• Subsidize irrigation infrastructure • Promote low-meat diets that can reduce the cropland required for feeding livestock, thereby reducing agricultural demand
Preferred	• Subsidize irrigation infrastructure only
High cost	• Subsidize irrigation infrastructure • Subsidize electricity for water extraction

For the 41 countries included in our analysis, the annual required spending on the irrigation subsector between 2015 and 2030 is estimated to be roughly 0.12 percent of GDP, or $5.8 billion in 2017 constant prices. This required spending corresponds to the low-cost scenario, which includes only subsidies for irrigation infrastructure and a policy promoting low-meat diets (Rozenberg and Fay 2019) (figure 2.2.2). However, a more reasonable scenario is the preferred scenario, where it is assumed that subsidies would be provided for irrigation infrastructure but not for water consumption, and without the low-meat diet policy. This would cost around 0.13 percent of GDP (Rozenberg and Fay 2019) or $6.3 billion per year for the same set of countries. Lastly, if subsidies also included the electricity consumption required for water extraction, the annual spending requirement would increase to 0.20 percent of GDP, or $9.6 billion in 2017 prices (Rozenberg and Fay 2019)—the high-cost scenario.

FIGURE 2.2.3 **Estimated Average Annual Irrigation Spending Requirements, 2015–30, by Scenario and Region**



Source: Authors' estimates using data from Rozenberg and Fay (2019).

As a share of regional GDP in 2017, the irrigation spending requirements differ significantly from region to region. In all three scenarios, SSA and SA have the highest annual spending requirements, with EAP close behind. LAC and ECA have the lowest spending requirements. This disparity is not surprising considering that SA accounted for 33 percent of the world's total irrigated area. In comparison, based on the best available estimates from 2010, LAC had only 6 percent (Fox et al. 2019). In the preferred scenario, the annual spending requirement for irrigation in SSA could be as high as 0.35 percent of GDP ($1.3 billion), and for SA as high as 0.27 percent ($1.6 billion).

Estimated Current Spending

WATER AND SANITATION

As discussed in part 2 chapter 1, current annual public spending in the WSS subsector was estimated by adopting the methodology outlined in Fay et al. (2019). We calculated three levels of estimates for annual total spending in WSS (table 2.2.3):

1. A lower-bound estimate that includes only the government expenditure through the budget, both available and estimated, from BOOST
2. A middle estimate that augments the lower-bound estimate with private sector capital expenditure from the PPI-SPI database
3. An upper-bound estimate that refines the middle estimate with the regional mean of SOE spending obtained from the PPI-SPI database.

For the initial analysis encompassing 130 countries, we estimated that the total annual spending in the WSS ranged from $79.9 billion for the lower bound to $90.7 billion for the upper bound. The middle estimate for total water sector expenditure was $82.6 billion. In the subsequent analysis in this chapter, we focus on the 113 out of the initial 130 countries for which estimates on annual spending requirements in WSS were available. Within this section, we will continue to provide the same three estimates for the 113 countries, summarized in the table below:

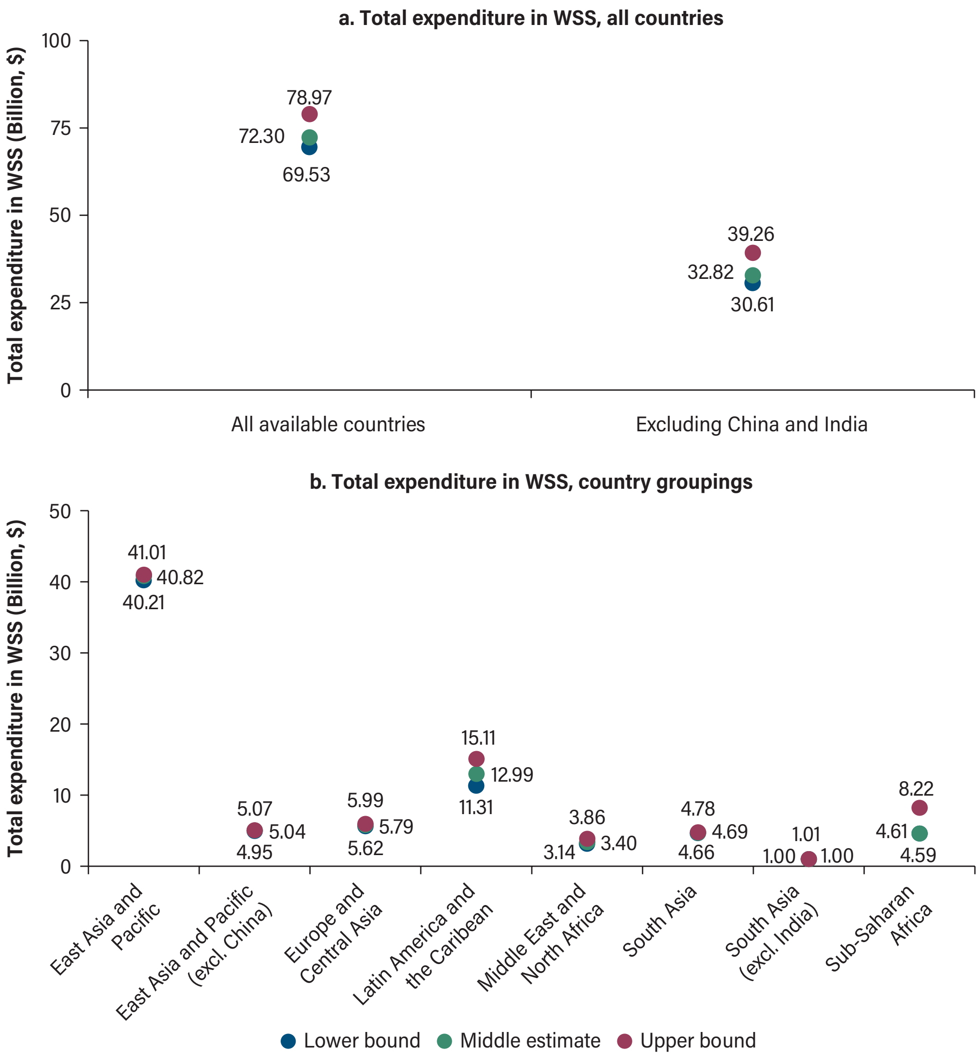
TABLE 2.2.3 Three Estimates of Current Spending in WSS

Estimate	Definition
Lower bound	• Government fiscal spending only (actual and estimated values from BOOST)
Middle estimate	• Lower estimate plus private sector capital spending where available, based on the SPI PPI database
Upper bound	• Fiscal spending • PPIs but with the former augmented by the regional mean for spending by SOEs

Note: Official development assistance is not included. WSS = water supply and sanitation; SOEs = state-owned enterprises; PPI = private participation in infrastructure.

For the 113 countries, total annual spending in the WSS subsector is estimated to be between \$69.5 billion and \$79.0 billion, with a middle estimate of \$72.3 billion in 2017 constant prices (figure 2.2.4). These values correspond to between 0.24 percent and 0.27 percent of GDP, with a middle estimate of 0.25 percent (figure 2.26). Notably, if we exclude China and India, the estimated annual spending drops to between \$30.6 billion (0.22 percent of GDP) and \$39.3 billion (0.28 percent), respectively, with a middle estimate of \$32.8 billion (0.23 percent). This indicates that China and India together cover nearly half of the estimated annual spending on WSS.

FIGURE 2.2.4 Estimated Annual Total Spending in WSS, by Region (2017 constant prices)

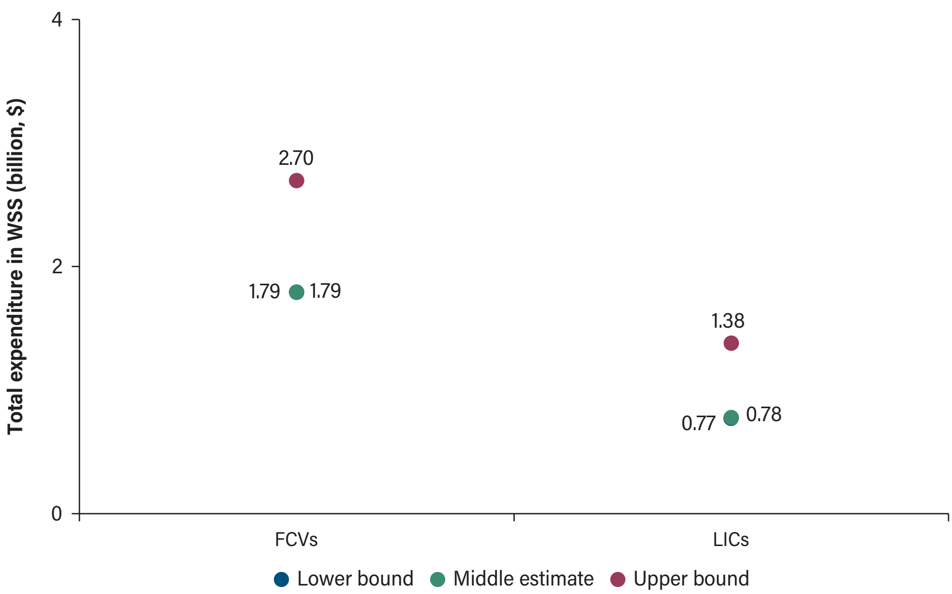


Source: Authors' estimates using BOOST database.
Note: WSS spending figures are from the previous chapter's predictions based on refinement. Figures differ slightly from the previous chapter because of different study samples. This analysis includes only the 113 countries whose spending requirements information is available in Hutton and Varughese (2020). ODA is not included. WSS = water supply and sanitation.

As before, regionally, EAP countries collectively outspend all other regions, with annual WSS expenditure estimated to be between $40.2 billion (0.27 percent) and $41.0 billion (0.28 percent). However, the share of GDP spent on WSS in the MENA region has decreased significantly. In the preceding chapter, it was estimated to range between 0.52 percent and 0.62 percent, but in this chapter, the figures have dropped by nearly half, to between 0.24 percent and 0.30 percent of GDP. This drop is primarily due to the exclusion of Saudi Arabia (along with two other countries) from the analysis, because data on spending requirements for these countries were unavailable. A comparison of both sets of estimates are presented in table 2.2.4.

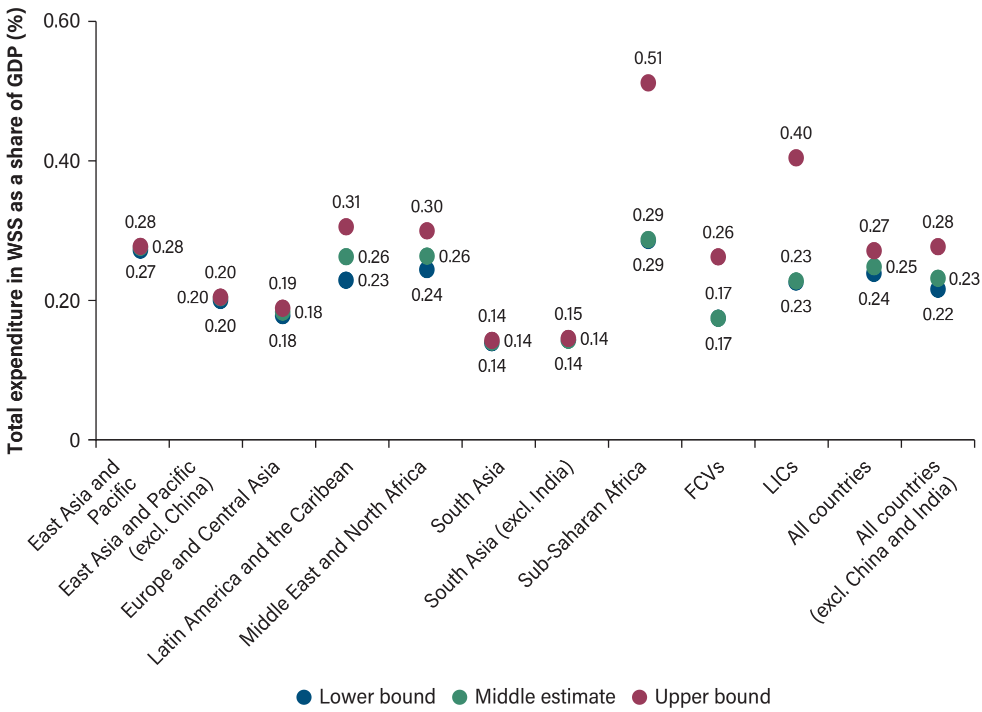
FCVs collectively spend only around $1.79 billion (0.17 percent) to $2.70 billion (0.26 percent) annually, while LICs spend between $0.77 billion (0.23 percent) and $1.38 billion (0.40 percent) in WSS (figure 2.25). These figures correspond to GDP shares that are well within the range of the global average for the 113 countries (figure 2.26). In absolute terms, however, the spending is modest, reflecting the significant financial challenges these nations are facing in developing their WSS sector. This echoes the concerns raised in previous Joint Monitoring Programme (JMP) reports, particularly the wide coverage gap to safely managed services in these countries (WHO and UNICEF, 2021 2023).

FIGURE 2.2.5 Estimated Annual Total Spending on WSS in FCV and Low-Income Countries (2017 constant prices)



Source: Authors' estimates using BOOST database.
Note: WSS spending figures come from the previous chapter's predictions based on refinement. Figures slightly differ from the previous chapter because of different study samples. This analysis includes only the 113 countries whose spending requirements information is available in Hutton and Varughese (2020). Official development assistance is not included. FCV = fragile, conflict-affected, and vulnerable; LIC = low-income country; WSS = water supply and sanitation.

FIGURE 2.2.6 Estimated Annual Total Spending in WSS as share of GDP, by Region and Country Grouping



Source: Authors' estimates using BOOST database.
Note: WSS spending figures come from the previous chapter's predictions based on refinement. Figures differ slightly from the previous chapter because of different study samples. ODA is not included. This analysis includes only the 113 countries whose spending requirements information is available in Hutton and Varughese (2020).

TABLE 2.2.4 Comparison of Estimated Annual Total Spending in WSS from Part 2 Chapter 1 and Part 2 Chapter 2

	Estimates from part 2 chapter 1				
Spending in 2017 constant prices (Billion, $)	Number of countries	GDP	Lower bound	Middle estimate	Upper bound
East Asia and Pacific	14	$14,785.9	$40.2	$40.8	$41.0
Europe and Central Asia	24	$4,341.0	$7.4	$7.6	$7.8
Latin America and the Caribbean	28	$5,323.2	$12.0	$13.6	$15.9
Middle East and North Africa	12	$2,083.3	$11.0	$11.3	$12.9
South Asia	8	$3,348.2	$4.7	$4.7	$4.8
Sub-Saharan Africa	44	$1,607.2	$4.6	$4.6	$8.2
Low-income countries	21	$341.4	$0.8	$0.8	$1.4

table continues next page

TABLE 2.2.4 Comparison of Estimated Annual Total Spending in WSS from Part 2 Chapter 1 and Part 2 Chapter 2 *(continued)*

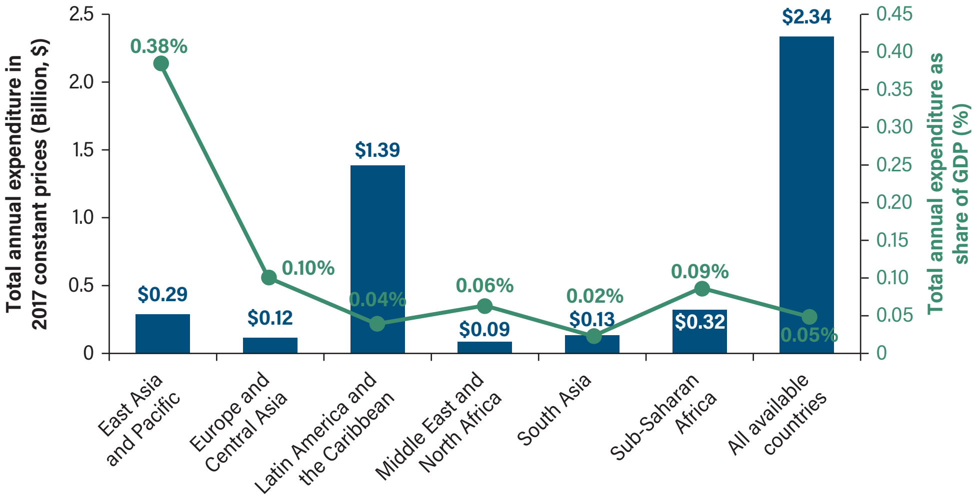
Spending in 2017 constant prices (Billion, $)	Number of countries	GDP	Lower bound	Middle estimate	Upper bound
Estimates from part 2 chapter 1					
FCV countries	24	$1,146.0	$1.8	$1.8	$2.7
All available countries	130	$31,488.8	$79.9	$82.6	$90.7
Estimates for this chapter					
East Asia and Pacific	14	$14,785.9	$40.2	$40.8	$41.0
Europe and Central Asia	16(8)	$3,160.1	$5.6	$5.8	$6.0
Latin America and the Caribbean	23(5)	$4,946.7	$11.3	$13.0	$15.1
Middle East and North Africa	9(3)	$1,288.5	$3.1	$3.4	$3.9
South Asia	8	$3,348.2	$4.7	$4.7	$4.8
Sub-Saharan Africa	43(1)	$1,605.7	$4.6	$4.6	$8.2
Low-income countries	21	$341.4	$0.8	$0.8	$1.4
FCV countries	23(1)	$1,028.0	$1.8	$1.8	$2.7
All available countries	113(17)	$29,134.7	$69.5	$72.3	$79.0

Source: Authors' estimates using BOOST database.
Note: WSS spending figures come from the previous chapter's predictions based on refinement. Figures differ slightly from the previous chapter because of different study samples. ODA is not included. This analysis includes only the 113 countries whose spending requirements information is available in Hutton and Varughese (2020). FCV = fragile, conflict-affected, and vulnerable; WSS = water supply and sanitation.

IRRIGATION

Based on the data for 41 countries in the BOOST database, it is estimated that, on average, $2.3 billion (0.05 percent of 2017 GDP) was spent on irrigation annually (figure 2.2.7). Significant regional variations can be observed. EAP has the highest irrigation spending as a share of GDP, at 0.38 percent, followed by ECA (0.10 percent) and then SSA (0.09 percent), while SA (excluding India) spent only 0.02 percent, despite being one of the more agriculture-intensive regions.[12] Unfortunately, no actual spending information by the SOEs and the private sector is available for the irrigation subsector to estimate the relative expenditures of the private sector and the SOEs. Current annual spending was therefore estimated based on the available fiscal spending information from the BOOST database. It should also be noted that in a vast majority of countries, irrigation infrastructure spending primarily comes from the government or from semi-government agencies.

FIGURE 2.2.7 Estimated Annual Total Spending on Irrigation, in 2017 constant prices and as a share of GDP, by Region



Source: Authors' elaboration using BOOST database.
Note: Official development assistance is not included. Only 41 countries are included in this analysis.

Estimated Annual Spending Gaps for the WSS and Irrigation Subsectors

WATER AND SANITATION

This section presents the estimated annual spending gaps in the WSS subsector calculated as the difference between the estimated *actual* annual spending and the estimated average annual spending requirements that the 113 countries would need in order to achieve their respective sector-specific targets by 2030, as detailed in preceding sections. For each of the two targets, we calculated three estimates of spending gaps—lower, middle, and higher—summarized in table 2.2.5 below. The lower estimate refers to the lower estimated value of the spending gap and the higher estimate refers to the higher estimated value of the spending gap.

TABLE 2.2.5 Three Estimates of Annual Spending Gaps in WSS

Estimate	Definition
Lower Estimate	• The difference between the annual spending requirement for the respective target (Universal Basic WASH or SDG 6.1 and 6.2) and **lower bound** of annual spending in WSS
Middle Estimate	• The difference between the annual spending requirement for the respective target (Universal Basic WASH or SDG 6.1 and 6.2) and **middle estimate** of annual spending in WSS
Higher Estimate	• The difference between the annual spending requirement for the respective target (Universal Basic WASH or SDG 6.1 and 6.2) and **upper bound** of annual spending in WSS

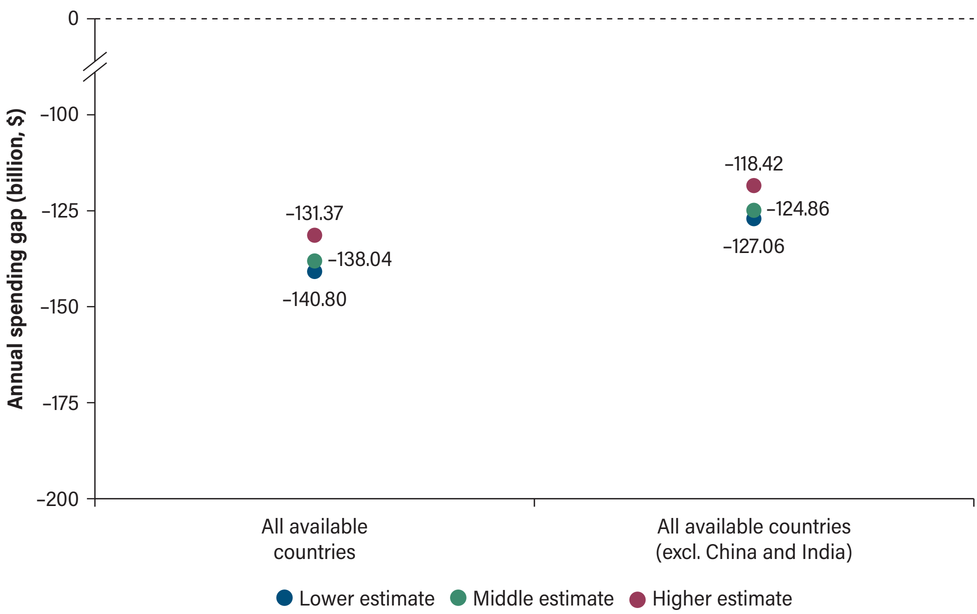
Overall, countries are currently spending enough on an annual basis to achieve universal access to *basic WASH services* by 2030 (table 2.2.6). Indeed, it is estimated that, collectively, the countries currently maintain an annual surplus of between \$12.9 billion (or 0.04 percent of total GDP) and \$22.3 billion (or 0.08 percent of total GDP) in 2017 constant prices, with a middle estimate of an annual surplus of about \$15.6 billion (0.05 percent of GDP). This surplus, however, comes mainly from EAP, ECA, and LAC. The EAP region, including China, has the highest spending surplus, estimated to be between \$30.3 billion (0.20 percent) and \$30.8 billion (0.21 percent) annually. If China is excluded, the region's annual spending surplus in WSS markedly decreases to between \$0.18 billion (0.01 percent) and \$0.30 billion (0.01 percent). Consequently, the global spending surplus also virtually disappears. In short, the spending surplus to achieve universal basic WASH access by 2030 is driven almost entirely by China's spending. In contrast, SA, MENA, and SSA have annual shortfalls between required and actual spending (across all estimates). As with China and EAP, the shortfall in SA increases if the main contributor, India, is excluded.

However, to achieve the targets for universal access to safely managed water supply and sanitation by 2030 (figure 2.2.8), the countries are falling significantly short, financially. The estimated annual spending gap or shortfall between 2017 and 2030 to achieve these higher targets ranges from \$131.4 billion to \$140.8 billion, with a middle estimate of \$138.0 billion in 2017 prices. These figures represent between 0.45 percent and 0.48 percent of the 113 countries' overall GDP. On average, countries will need to increase annual spending levels to between 2.7 and 3.0 times the current level to bridge this spending gap. If China and India are excluded, the annual spending gap as a share of GDP further widens to between 0.84 percent and 0.90 percent—practically almost doubling—corresponding to a spending shortfall of \$118.4 billion and \$127.1 billion.

Among the regions, SSA has the largest annual spending gap to achieving this target, followed by SA and MENA. The annual spending gap for SSA to meet SDGs 6.1 and 6.2 is estimated to be between \$69.9 billion (4.35 percent of GDP) and \$73.5 billion (4.58 percent of GDP) in 2017 prices; and for SA, between \$36.0 billion (1.08 percent) and \$36.1 billion (1.08 percent). If India is left out, the annual spending gap in SA substantially declines to between \$10.78 billion (1.55 percent) and \$10.79 billion (1.55 percent), indicating that, in absolute dollars, India alone covers more than two-thirds of the region's annual spending gap. This is consistent with the JMP's findings that SSA and SA have the lowest coverage rates of safely managed water and sanitation services in their respective populations (WHO and UNICEF 2021). In contrast, the EAP region, including China, has the smallest spending gap to achieving the SDG targets by 2030.

The spending surplus to achieve universal basic WASH access by 2030 is driven almost entirely by China. In contrast, South Asia, Sub-Saharan Africa, and the Middle East and North Africa have annual shortfalls between required and actual spending.

FIGURE 2.2.8 Estimated Annual Spending Gaps to Meet SDG Targets 6.1 and 6.2 (2017 constant prices)



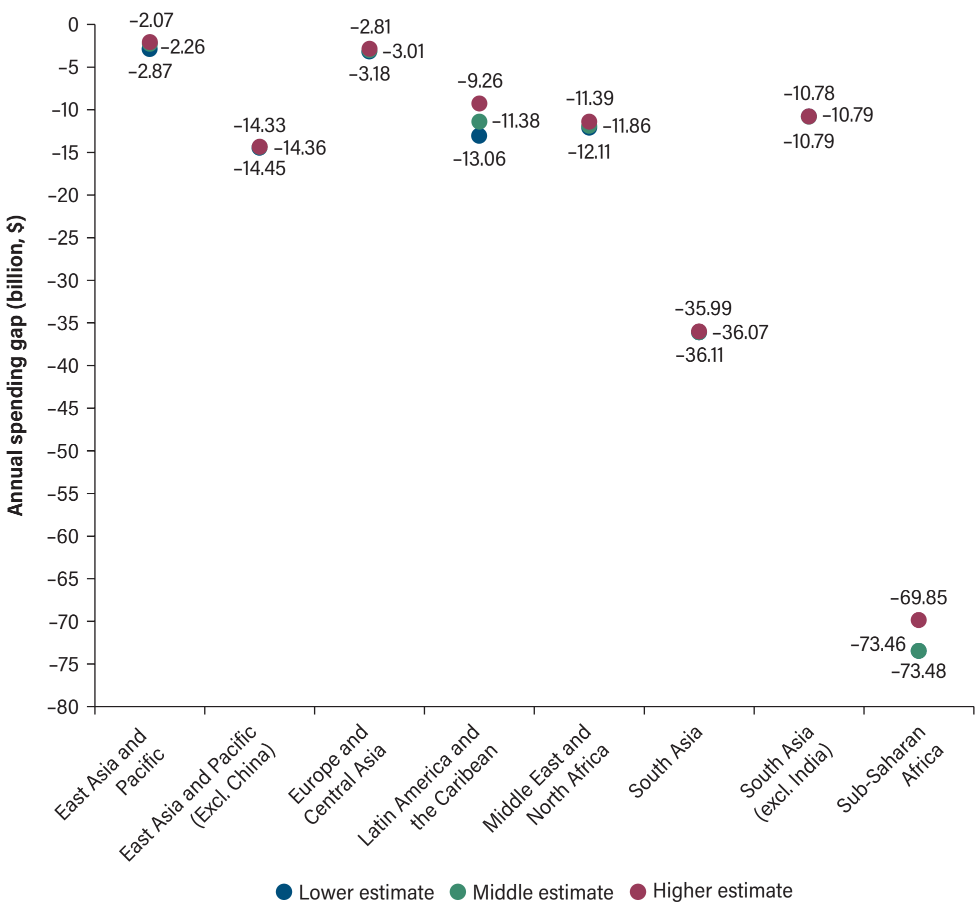
Source: Authors' estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: This analysis includes only the 113 countries whose spending requirements information is available in Hutton and Varughese (2020).

Indeed, most countries in our analysis are falling short of the spending needed to achieve SDG targets for WSS by 2030. As indicated in map 2.2.1, below, all SSA and SA countries have spending shortfall (lower estimate). Only 8 of the 113 countries have spending surplus to achieve the SDG targets for WSS. In contrasts, 52 countries are spending enough annually to attain universal basic WASH access by 2030. This underscores a recurring theme highlighted in previous reports—achieving universal access to basic WASH by 2030 is perhaps a more realistic and feasible target (Fox et al. 2019; WHO and UNICEF 2021). Nevertheless, although progress has been made, particularly over the last decade, most countries in our analysis are still lagging (for both targets), emphasizing the need for continued investments to ensure access to safely managed WASH services for all.

Meeting SDG targets would necessitate at least a fourfold increase in the rate of progress achieved between 2015 and 2020 in terms of expanding access to safely managed WASH services.

The substantial spending gap to achieve SDG 6.1 and 6.2 by 2030 underscores the urgent need for action. Regrettably, current rates of progress suggest that these targets may not be met by 2030. As discussed earlier, meeting these targets, assuming the sector maintains constant productivity and efficiency levels, would necessitate at least a fourfold increase in the rate of progress between 2015 and 2020 in terms of expanding access to safely managed WASH services (WHO and UNICEF 2021).[13] From a financial standpoint, this means that annual spending on WSS will need to increase to a minimum of 2.7 times its current level. If exclude China and India, the rest of the world would need to raise their annual WSS spending by a factor of four to five to bridge this financial gap. Regionally, the most significant challenge would be faced by SSA, where the required spending would need to increase to between 9.5 and 17.0 times, followed by SA, between 8.5 and 8.8 times.

FIGURE 2.2.9 Estimated Annual Spending Gaps to Reach SDG Targets 6.1 and 6.2, by Region (2017 constant prices)

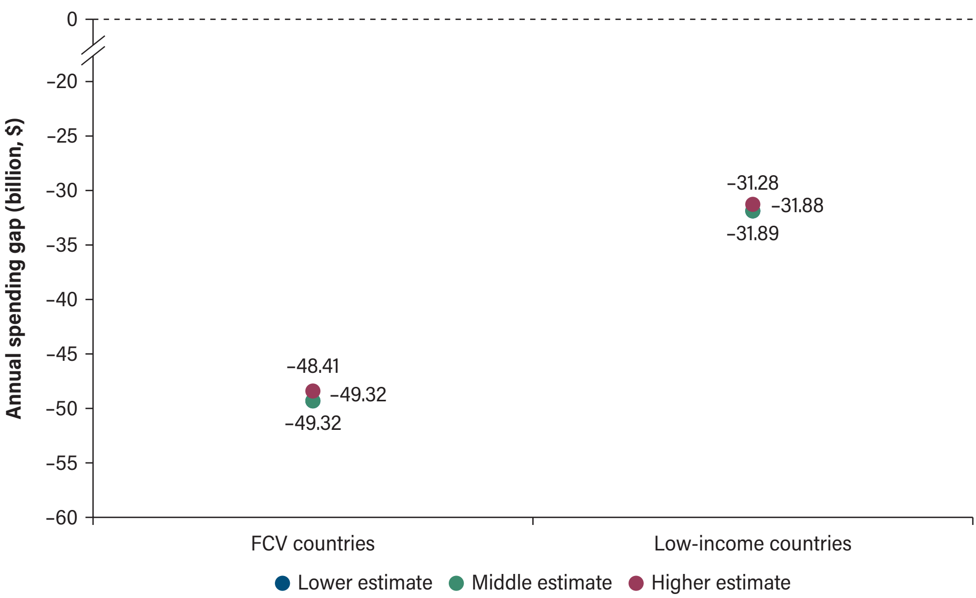


Source: Authors' estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: This analysis includes only the 113 countries whose spending requirements information is available in Hutton and Varughese (2020).

However, the challenge of meeting the SDG targets for universal safely managed WASH services is even more formidable for FCVs and the least developed countries (LICs). The annual spending gap to achieve these targets is estimated to be between

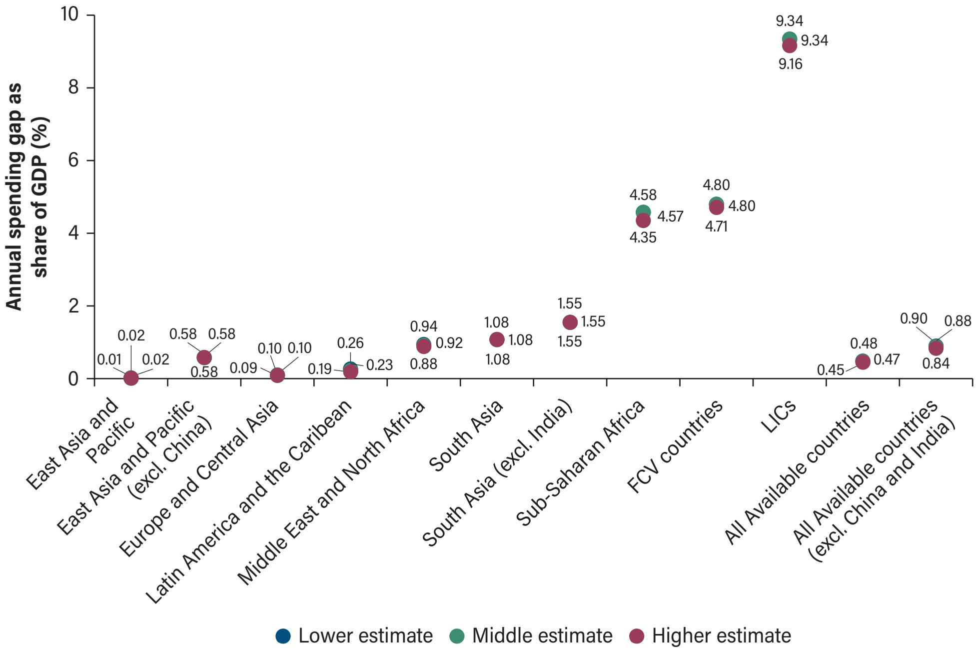
4.71 and 4.80 percent for FCVs, and even higher for LICs—between 9.16 percent and 9.34 percent. These spending gaps, expressed as a share of GDP, are more than ten times the global average (0.45 percent to 0.47 percent), pointing to the enormous financial challenges faced by FCVs and LICs to meet the SDG targets. Likewise, to bridge these financial gaps, FCV countries will need to increase their annual spending to roughly between 19.0 and 28.5 times the current level, and LICs between 23.7 and 42.3 times. All in all, at least 22.7 percent of the overall annual spending gaps to meet SDG targets 6.1 and 6.2 by 2030 comes from LICs, and 35.0 percent from FCVs. Again, our findings for FCVs and LICs echo recent JMP reports. Assuming constant rates of progress between 2015 and 2020, FCVs countries will require a significantly higher rate of progress to achieve universal access to safely managed WASH services by 2030, as compared to the global average (WHO and UNICEF 2021).

FIGURE 2.2.10 Estimated Annual Spending Gaps to Achieving SDGs 6.1 and 6.2 in FCV and Low-Income Countries, in 2017 constant prices



Source: Authors' estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: FCV = fragile, conflict-affected, and vulnerable.

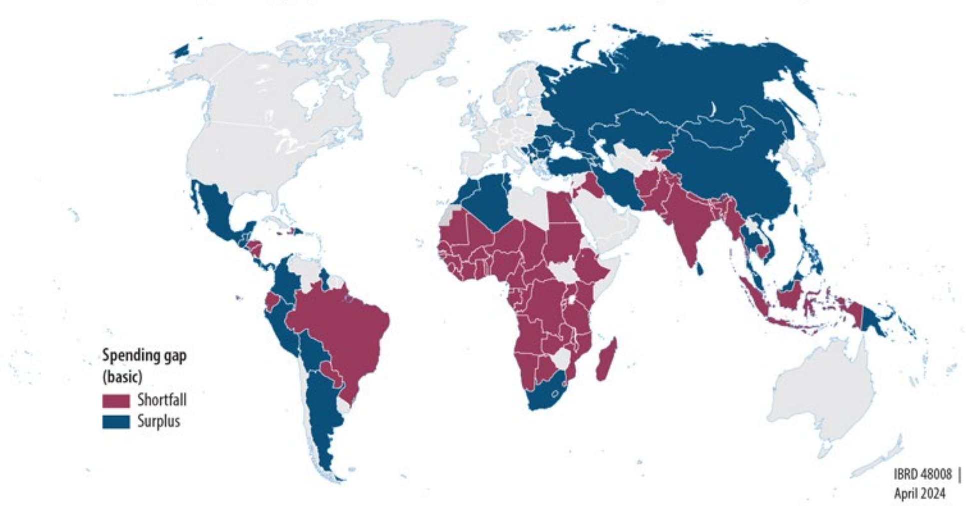
FIGURE 2.2.11 Estimated Annual Spending Gaps to Achieving SDG 6.1 and 6.2 as a Share of GDP, by Region and Country Grouping



Source: Authors' estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: Values are expressed in absolute terms. FCV = fragile, conflict-affected, and vulnerable; LIC = low-income country; SDG = Sustainable Development Goal.

MAP 2.2.1 Global Map of Relative Country Spending Gaps to Universal Access to Basic WASH and to Full SDG Targets 6.1 and 6.2 by 2030

a. Spending gap to universal access to basic WASH (lower estimate)



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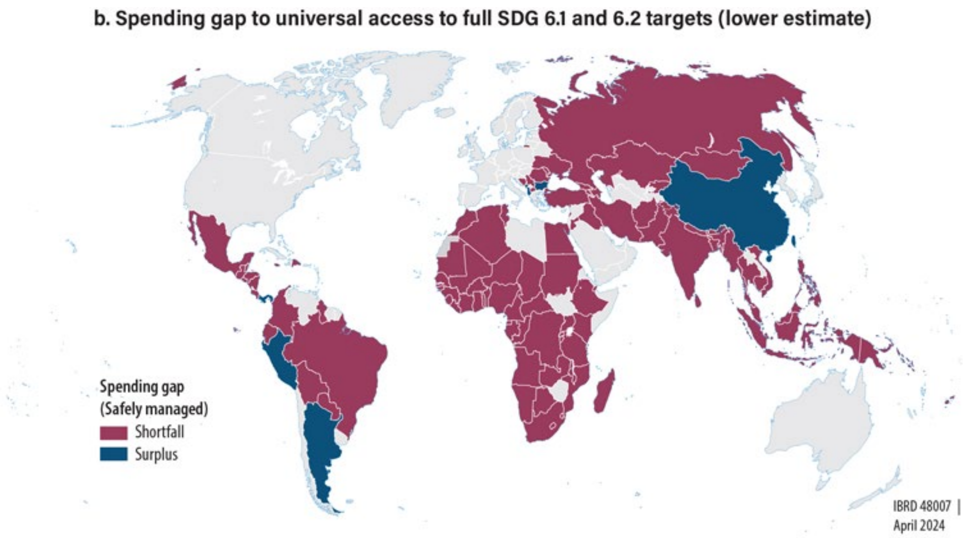
MAP 2.2.1 Global Map of Relative Country Spending Gaps to Universal Access to Basic WASH and to Full SDG Targets 6.1 and 6.2 by 2030 (*Continued*)



Source: Author's estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene.

TABLE 2.2.6 Annual Spending Gaps to Universal Basic WASH and to SDG Targets 6.1 and 6.2, in 2017 Prices and as a Share of GDP

	Estimated annual spending gaps (2017–2030)					
	Lower estimate	Middle estimate	Higher estimate	Lower estimate	Middle estimate	Higher estimate
Universal basic WASH	Billion ($)			Share of GDP		
East Asia and Pacific	$30.03	$30.65	$30.84	0.20%	0.21%	0.21%
East Asia and Pacific (excl. China)	$0.18	$0.28	$0.30	0.01%	0.01%	0.01%
Europe and Central Asia	$3.90	$4.07	$4.27	0.12%	0.13%	0.14%
Latin America and the Caribbean	$5.93	$7.61	$9.72	0.12%	0.15%	0.20%
Middle East and North Africa	–$0.10	$0.15	$0.62	–0.01%	0.01%	0.05%
South Asia	–$5.36	–$5.32	–$5.24	–0.16%	–0.16%	–0.16%
South Asia (excl. India)	–$1.21	–$1.21	–$1.19	–0.17%	–0.17%	–0.17%
Sub-Saharan Africa	–$21.55	–$21.53	–$17.92	–1.34%	–1.34%	–1.12%
FCV countries	–$16.67	–$16.67	–$15.77	–1.62%	–1.62%	–1.53%
LICs	-$11.44	–$11.44	–$10.83	–3.35%	–3.35%	–3.17%
All available countries	$12.85	$15.62	$22.29	0.04%	0.05%	0.08%
Excluding China and India	–$12.84	–$10.63	–$4.20	–0.09%	–0.08%	–0.03%

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TABLE 2.2.6 Annual Spending Gaps to Universal Basic WASH and to SDG Targets 6.1 and 6.2, in 2017 Prices and as a Share of GDP *(continued)*

	Estimated annual spending gaps (2017–2030)					
	Lower estimate	Middle estimate	Higher estimate	Lower estimate	Middle estimate	Higher estimate
SDG Targets 6.1 and 6.2	Billion ($)			Share of GDP		
East Asia and Pacific	−$2.87	−$2.26	−$2.07	−0.02%	−0.02%	−0.01%
East Asia and Pacific (excl. China)	−$14.45	−$14.36	−$14.33	−0.58%	−0.58%	−0.58%
Europe and Central Asia	−$3.18	−$3.01	−$2.81	−0.10%	−0.10%	−0.09%
Latin America and the Caribbean	−$13.06	−$11.38	−$9.26	−0.26%	−0.23%	−0.19%
Middle East and North Africa	−$12.11	−$11.86	−$11.39	−0.94%	−0.92%	−0.88%
South Asia	−$36.11	−$36.07	−$35.99	−1.08%	−1.08%	−1.08%
South Asia (excl. India)	−$10.79	−$10.79	−$10.78	−1.55%	−1.55%	−1.55%
Sub-Saharan Africa	−$73.48	−$73.46	−$69.85	−4.58%	−4.57%	−4.35%
FCV countries	−$49.32	−$49.32	−$48.41	−4.80%	−4.80%	−4.71%
LICs	−$31.89	−$31.88	−$31.28	−9.34%	−9.34%	−9.16%
All available countries	−$140.80	−$138.04	−$131.37	−0.48%	−0.47%	−0.45%
Excluding China and India	−$127.06	−$124.86	−$118.42	−0.90%	−0.88%	−0.84%

Source: Authors' estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: FCV = fragile, conflict-affected, and vulnerable; GDP = gross domestic product; LIC = low-income country; SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene; WSS = water supply and sanitation.

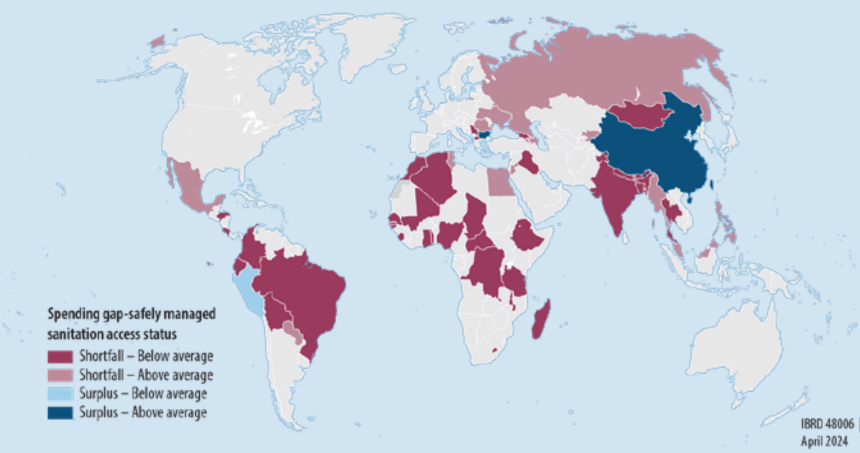
BOX 2.2.1 Achieving Universal Access to Safely Managed WASH Services by 2030: A Brief Review on Spending Performance and Access Levels

Under SDG target 6.2, countries aim to achieve universal access to safely managed sanitation services by 2030. But based on current progress, most of the world is not on track to achieving this goal. In 2020, 3.6 billion people worldwide lacked access to safely managed sanitation services (WHO and UNICEF 2021).

As part of our analysis, we examined how well 57 countries were doing in achieving full access to safely managed sanitation in 2020 (WHO and UNICEF 2021). We estimated spending gaps by comparing their current access levels to what it would take to achieve universal access and grouped the countries into two clusters (map B2.2.1.1): A **low-access** group with coverage below 53.95 percent—the global average of access to safely managed sanitation—and a **high-access** group with above-average coverage (WHO and UNICEF 2021). We also clustered the countries into those with a spending gap shortfall (as far as achieving the SDG targets by 2030), and those with a spending surplus. This yielded a two-by-two matrix that offers insights into country performance.

Of the 57 countries, 40 were low-access, 37 of which had a spending shortfall. Only 3 low-access countries—Peru, Albania, and Montenegro—are spending above the required levels (spending surplus) to achieve those targets. Although this could indicate that the three countries are proactively spending on WASH to address coverage, the greater spending could also indicate inefficiencies resulting in lower returns to investments that prompt higher spending, since quantity is not necessarily quality.

MAP B2.2.1.1 Global Map of Performance in 57 Select Countries Measured by How Much They Spent to Achieve SDG 6.1 and 6.2 versus Actual Degree of Access to Safely Managed Sanitation, in 2020



Source: Author's estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: WASH = water supply, sanitation, and hygiene.

By contrast, of the 17 countries that have higher-than-average access levels to safely managed sanitation services, 15 are actually spending *less than* what is required of them to achieve universal safely managed sanitation by 2030. Although the populations of these 15 countries have relatively high access to safely managed sanitation, this should not invite complacency. Indeed, among the 15, only Kyrgyzstan had more than 90 percent access to safely managed sanitation in 2020.

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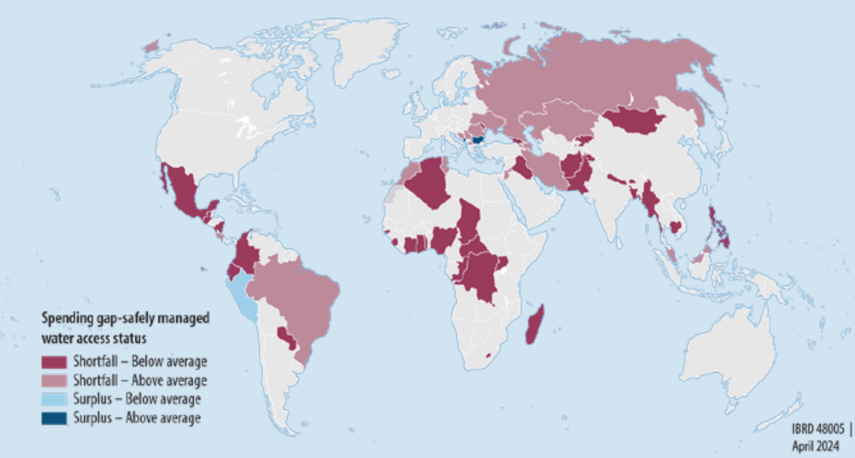
BOX 2.2.1 Achieving Universal Access to Safely Managed WASH Services by 2030: A Brief Review on Spending Performance and Access Levels (*Continued*)

Additionally, achieving 100 percent universal access from 90 percent is not as easy as achieving 60 percent from 50 percent because the challenges of last-mile service delivery and other inefficiencies often result in diminishing marginal returns that entail higher and higher spending levels to increase coverage. Achieving universal access is therefore not as easy as might be thought. Only two of the 17 high-access countries, China and Bulgaria, are spending more than what is required (spending surplus) to achieve universal access to safely managed sanitation by 2030.

Map B2.2.1.2 presents a similar map of country performance for access to safely managed water services in 59 countries. While the spending shortfall/surplus groupings are the same, this time the global average level of access to safely managed water services is estimated to be around 74.27 percent in 2020 (WHO and UNICEF 2021). We nevertheless find a similar overall trend. Most countries have low access and are not spending enough (spending shortfalls) on WSS to achieve universal access to safely managed water services by 2030. Again, Peru and Albania are investing more than what is required yet, despite this, continue to have low access. On the other hand, Bulgaria and Montenegro are spending enough and have higher-than-average access.

Overall, given the current spending patterns, only a few countries will likely achieve universal access to safely managed water and sanitation services by 2030. Most low- and middle-income countries with populations that have low access to these services are not spending enough to reach the SDG targets, mirroring the findings of the JMP report (WHO and UNICEF 2021).

MAP B2.2.1.2 Global Map of Performance in 59 Select Countries Measured by How Much They Spent to Achieve SDG 6.1 versus Actual Degree of Access to Safely Managed Water Supply Services, in 2020



Source: Author's estimates using data from Hutton and Varughese (2020) and the BOOST database.
Note: WASH = water supply, sanitation, and hygiene.

IRRIGATION

Regarding irrigation, on average, the 41 countries in this analysis for which data were available are not spending enough to achieve the low-cost target by 2030 (Rozenberg and Fay 2019). Cumulatively, the 41 countries have an annual spending shortfall of $3.5 billion between 2015 and 2030—about 0.07 percent of their 2017 GDP. The figures reported in this section are shown below, in table 2.2.7.

TABLE 2.2.7 Estimated Average Annual Spending Gaps in Irrigation, in 2017 Constant Prices and as a Share of GDP

	Estimated Annual Spending Gaps	
Scenario	Billion ($)	Share of GDP
Low cost		
South Asia	–1.26	–0.22%
East Asia and Pacific	0.21	0.27%
Middle East and North Africa	–0.02	–0.02%
Sub-Saharan Africa	–0.87	–0.23%
Europe and Central Asia	0.08	0.07%
Latin America and the Caribbean	–0.38	–0.01%
All countries	–3.45	–0.07%
Preferred cost		
South Asia	–1.43	–0.25%
East Asia and Pacific	0.19	0.25%
Middle East and North Africa	–0.05	–0.04%
Sub-Saharan Africa	–0.98	–0.26%
Europe and Central Asia	0.07	0.06%
Latin America and the Caribbean	–1.09	–0.03%
All countries	–3.93	–0.08%
Max cost		
South Asia	–2.36	–0.41%
East Asia and Pacific	0.12	0.15%
Middle East and North Africa	–0.13	–0.10%
Sub-Saharan Africa	–2.35	–0.63%

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TABLE 2.2.7 Estimated Average Annual Spending Gaps in Irrigation, in 2017 constant prices and as a share of GDP (*Continued*)

	Estimated Annual Spending Gaps	
Scenario	Billion ($)	Share of GDP
Europe and Central Asia	−0.15	−0.13%
Latin America and the Caribbean	−6.41	−0.18%
All countries	−7.31	−0.15%

Source: Author's elaboration using data from Rozenberg and Fay (2019) and BOOST database.

With the "Preferred" cost target, the irrigation spending gap widens further. For the 41 countries, the annual shortfall increases to $3.9 billion—0.08 percent of their 2017 GDP. The average annual spending requirement is almost three times higher than the estimated average amount spent annually between 2009 and 2020—$6.3 billion vs. $2.3 billion—based on BOOST data. Finally, to achieve the high cost as defined in Rozenberg and Fay (2019), the corresponding spending shortfall increases to $7.3 billion, or 0.15 percent of total GDP in 2017.

Despite being an agriculture-intensive region (World Bank 2021), SSA has the highest spending gap among all the regions, estimated to be about -0.26 percent, or almost $1.0 billion to achieve the preferred target. This is followed by SA, which has an annual spending gap of $1.4 billion, or −0.25 percent of 2017 GDP. In contrast, EAP has been spending more than is required to achieve even the high-cost target.

Summary Tables

WATER SUPPLY AND SANITATION (WSS) UNIVERSAL BASIC WASH ACCESS

TABLE 2.2.8 Estimated Annual Spending Requirements, Annual Total Spending, and Annual Spending Gaps to Achieving Universal Basic WASH Access (2017 constant prices)

			Estimated Total Annual Spending			Estimated Annual Spending Gaps (2017-2030)					
	GDP (2017)	Estimated annual spending requirements (2017–30)	Lower bound	Middle estimate	Upper bound	Lower estimate	Middle estimate	Higher estimate	Lower estimate	Middle estimate	Higher estimate
Universal Basic WASH	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	% GDP	% GDP	% GDP
East Asia and Pacific	$14,785.91	$10.18	$40.21	$40.82	$41.01	$30.03	$30.65	$30.84	0.20%	0.21%	0.21%
East Asia and Pacific (excl. China)	$2,475.91	$4.76	$4.95	$5.04	$5.07	$0.18	$0.28	$0.30	0.01%	0.01%	0.01%
Europe and Central Asia	$3,160.13	$1.72	$5.62	$5.79	$5.99	$3.90	$4.07	$4.27	0.12%	0.13%	0.14%
Latin America and the Caribbean	$4,946.65	$5.38	$11.31	$12.99	$15.11	$5.93	$7.61	$9.72	0.12%	0.15%	0.20%
Middle East and North Africa	$1,288.50	$3.24	$3.14	$3.40	$3.86	–$0.10	$0.15	$0.62	–0.01%	0.01%	0.05%
South Asia	$3,347.76	$10.01	$4.66	$4.69	$4.78	–$5.36	–$5.32	–$5.24	–0.16%	–0.16%	–0.16%
South Asia (excl. India)	$696.76	$2.20	$1.00	$1.00	$1.01	–$1.21	–$1.21	–$1.19	–0.17%	–0.17%	–0.17%
Sub-Saharan Africa	$1,605.71	$26.14	$4.59	$4.61	$8.22	–$21.55	–$21.53	–$17.92	–1.34%	–1.34%	–1.12%
FCVs	$1,027.97	$18.47	$1.79	$1.79	$2.70	–$16.67	–$16.67	–$15.77	–1.62%	–1.62%	–1.53%
LICs	$341.37	$12.21	$0.77	$0.78	$1.38	–$11.44	–$11.44	–$10.83	–3.35%	–3.35%	–3.17%
All Available Countries	$29,134.67	$56.68	$69.53	$72.30	$78.97	$12.85	$15.62	$22.29	0.04%	0.05%	0.08%
Excluding China and India	$14,173.67	$43.46	$30.61	$32.82	$39.26	–$12.84	–$10.63	–$4.20	–0.09%	–0.08%	–0.03%

Source: Authors' estimates using data from Hutton and Varughese (2020) and BOOST database.

TABLE 2.2.9 Estimated Annual Spending Requirements, Annual Total Spending, and Annual Spending Gaps to Achieving SDG Targets 6.1 and 6.2 (2017 constant prices)

SDG 6.1- 6.2 (Universal Safely Managed Sanitation)*	GDP (2017)	Estimated annual spending requirements (2017–30)	Estimated total annual spending			Estimated annual spending gaps (2017–30)					
			Lower bound	Middle estimate	Upper bound	Lower estimate	Middle estimate	Higher estimate	Lower estimate	Middle estimate	Higher estimate
	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	Billion ($)	% GDP	% GDP	% GDP
East Asia and Pacific	$14,785.91	$43.08	$40.21	$40.82	$41.01	–$2.87	–$2.26	–$2.07	–0.02%	–0.02%	–0.01%
East Asia and Pacific (excl. China)	$2,475.91	$19.40	$4.95	$5.04	$5.07	–$14.45	–$14.36	–$14.33	–0.58%	–0.58%	–0.58%
Europe and Central Asia	$3,160.13	$8.80	$5.62	$5.79	$5.99	–$3.18	–$3.01	–$2.81	–0.10%	–0.10%	–0.09%
Latin America and the Caribbean	$4,946.65	$24.37	$11.31	$12.99	$15.11	–$13.06	–$11.38	–$9.26	–0.26%	–0.23%	–0.19%
Middle East and North Africa	$1,288.50	$15.25	$3.14	$3.40	$3.86	–$12.11	–$11.86	–$11.39	–0.94%	–0.92%	–0.88%
South Asia	$3,347.76	$40.77	$4.66	$4.69	$4.78	–$36.11	–$36.07	–$35.99	–1.08%	–1.08%	–1.08%
South Asia (excl. India)	$696.76	$11.79	$1.00	$1.00	$1.01	–$10.79	–$10.79	–$10.78	–1.55%	–1.55%	–1.55%
Sub-Saharan Africa	$1,605.71	$78.07	$4.59	$4.61	$8.22	–$73.48	–$73.46	–$69.85	–4.58%	–4.57%	–4.35%
FCVs	$1,027.97	$51.11	$1.79	$1.79	$2.70	–$49.32	–$49.32	–$48.41	–4.80%	–4.80%	–4.71%
LICs	$341.37	$32.66	$0.77	$0.78	$1.38	–$31.89	–$31.88	–$31.28	–9.34%	–9.34%	–9.16%
All Available Countries	$29,134.67	$210.34	$69.53	$72.30	$78.97	–$140.80	–$138.04	–$131.37	–0.48%	–0.47%	–0.45%
Excluding China and India	$14,173.67	$157.68	$30.61	$32.82	$39.26	–$127.06	–$124.86	–$118.42	–0.90%	–0.88%	–0.84%

Source: Authors' estimates using data from Hutton and Varughese (2020) and BOOST database.

TABLE 2.2.10 Estimated Annual Spending Requirements, Annual Total Spending, and Annual Spending Gaps in Irrigation (2017 constant prices)

	GDP (2017)	Estimated annual irrigation spending requirements		Estimated annual irrigation spending		Estimated annual spending gap	
Scenario	Billion ($)	Billion ($)	Share of GDP	Billion ($)	Share of GDP	Billion ($)	Share of GDP
Low cost							
South Asia	$580.37	$1.39	0.24%	$0.13	0.02%	–$1.26	–0.22%
East Asia and Pacific	$75.58	$0.08	0.11%	$0.29	0.38%	$0.21	0.27%
Middle East and North Africa	$134.35	$0.11	0.08%	$0.09	0.06%	–$0.02	–0.02%
Sub-Saharan Africa	$371.91	$1.19	0.32%	$0.32	0.09%	–$0.87	–0.23%
Europe and Central Asia	$116.25	$0.03	0.03%	$0.12	0.10%	$0.08	0.07%
Latin America and the Caribbean	$3,543.73	$1.77	0.05%	$1.39	0.04%	–$0.38	–0.01%
All countries	$4,822.19	$5.79	0.12%	$2.34	0.05%	–$3.45	–0.07%
Preferred cost							
South Asia	$580.37	$1.57	0.27%	$0.13	0.02%	–$1.43	–0.25%
East Asia and Pacific	$75.58	$0.10	0.13%	$0.29	0.38%	$0.19	0.25%
Middle East and North Africa	$134.35	$0.13	0.10%	$0.09	0.06%	–$0.05	–0.04%
Sub-Saharan Africa	$371.91	$1.30	0.35%	$0.32	0.09%	–$0.98	–0.26%

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TABLE 2.2.10 Estimated Annual Spending Requirements, Annual Total Spending, and Annual Spending Gaps in Irrigation (2017 constant prices) (*Continued*)

	GDP (2017)	Estimated annual irrigation spending requirements		Estimated annual irrigation spending		Estimated annual spending gap	
Scenario	Billion ($)	Billion ($)	Share of GDP	Billion ($)	Share of GDP	Billion ($)	Share of GDP
Europe and Central Asia	$116.25	$0.05	0.04%	$0.12	0.10%	$0.07	0.06%
Latin America and the Caribbean	$3,543.73	$2.48	0.07%	$1.39	0.04%	–$1.09	–0.03%
All countries	$4,822.19	$6.27	0.13%	$2.34	0.05%	–$3.93	–0.08%
Maximum cost							
South Asia	$580.37	$2.50	0.43%	$0.13	0.02%	–$2.36	–0.41%
East Asia and Pacific	$75.58	$0.17	0.23%	$0.29	0.38%	$0.12	0.15%
Middle East and North Africa	$134.35	$0.21	0.16%	$0.09	0.06%	–$0.13	–0.10%
Sub-Saharan Africa	$371.91	$2.68	0.72%	$0.32	0.09%	–$2.35	–0.63%
Europe and Central Asia	$116.25	$0.27	0.23%	$0.12	0.10%	–$0.15	–0.13%
Latin America and the Caribbean	$3,543.73	$7.80	0.22%	$1.39	0.04%	–$6.41	–0.18%
All countries	$4,822.19	$9.64	0.20%	$2.34	0.05%	–$7.31	–0.15%

Source: Authors' estimates using data from Rozenberg and Fay (2019) and BOOST database.

Discussion and Closing Remarks

WHAT THE ESTIMATES DO NOT TAKE INTO ACCOUNT

Although the analysis presented in this section has attempted for the first time to systematically estimate the annual spending gaps in the water sector (WSS and irrigation), the actual gaps to achieve the respective sectoral targets presented earlier are likely to be higher because there are a number of factors that the estimate do not properly take into account. Several considerations had to be left out, considerations that would have had the effect of further widening the spending gaps.

Among them: (i) Several FCVs and LICs were left out of the analysis because of data availability issues; (ii) the rising costs of service provision and adapting water infrastructure to climate change and climate disasters were not included; (iii) the assumptions we made for estimating the WASH options low-income countries will choose have implications for our spending requirement estimates; (iv) the technology upgrade path countries choose in pursuing SDG-based WSS goals influences spending costs; and (v) changes in global macroeconomic conditions could influence the levels of spending in the water sector. It should prove insightful to briefly look at each of these in turn.

Because of data limitations, estimating a "true" spending gap in the water sector for achieving SDG targets that includes all the countries and economies of the world, while ideal, would have been impractical. There are data and monitoring limitations on both sides of the spending gap calculation—that is, spending requirement data limitations as well as actual spending data limitations. As a result, only 113 countries were included in the analysis of the WSS spending gap, and 41 for the irrigation spending gap, the majority being developing countries.

Moreover, many high-income economies have already achieved high levels of access and coverage and are on track to attaining the SDG targets by 2030. Including them in the spending gap estimations would have painted a rosier picture than the reality. As of 2020, on average, an estimated 98 percent of the population in high-income countries had access to safely managed water supply services, and 87 percent to safely managed sanitation services, although there is a pressing need for ongoing investments to maintain and rehabilitate aging infrastructure (WHO and UNICEF 2021). High-income countries also have a greater capacity to raise resources to finance infrastructure improvements on their own, with little to no dependence on assistance from the international development community. All of this means that the global spending gap estimated in this chapter really reflects that of low-income, lower-middle-income, and upper-middle-income developing countries. The 113 countries include just two high-income countries: Panama and Romania.

(i) ***Several FCVs and LICs excluded.*** First, as mentioned, the spending gaps are likely to be underestimated because several low-income and FCV countries are absent from the analysis. According to the latest JMP estimates, low-income economies will require a substantially higher rate of progress than the global average to meet the

SDG goals in WSS by 2030 (WHO and UNICEF 2021). Our analysis in this chapter reports similar findings. On average, low-income and FCV countries will need to increase their current levels of spending on WSS to almost 42.3 and 28.5 times and respectively, to bridge the spending gaps to achieve SDG 6.1 and 6.2, as compared to the global average of 202 percent (box 2.2.2).

(ii) ***Rising costs of adapting infrastructure to climate change and disasters.*** The calculation of spending requirements in this section also did not include the cost of adapting WSS infrastructure to climate change. The world's current levels of water consumption are unsustainable (Dalin, Taniguchi, and Green 2019; Hutton and Varughese 2016; Rosa et al. 2019). Today, because of climate change, many countries and cities are experiencing increasing water scarcity and/or high levels of water stress, making it costlier to provide continuous water services at the same level as before.

In 2019, on average, about 10 percent of the global population (733 million people) lived with high or critical levels of water stress where the level of demand, compared to availability, was unsustainable (United Nations 2022). Through the increase in global temperatures, climate change is expected to reduce even further the availability of freshwater resources, resulting in more water stress and scarcity (Jiménez Cisneros et al. 2014). It is estimated that, by 2040, as many as 33 countries could experience extremely high levels of water stress from climate change (Luo, Young, and Reig 2015).

Along with the current unsustainable levels of water consumption, climate change may therefore increase the future cost of providing and accessing bulk water. But this additional cost is not accounted for in our analysis (Hutton and Varughese 2016), which means we may be underestimating the spending gap. For example, Hughes, Chinowsky, and Strzepek (2010) have estimated that climate change could increase the costs of adapting water infrastructure among OECD countries by 1–2 percent, with the main driver being the extra cost of water resources to meet municipal water demand. Many water-scarce cities around the world have therefore begun investing in new but often costlier solutions to improve water storage and increase potable water availability (World Bank 2018). These adaptation costs for water infrastructure to climate change are not accounted for in the spending requirement portion in this chapter. Thus, the spending gap is likely to be underestimated (box 2.2.2).

Our spending requirements analysis also does not account for the potential costs of water infrastructure resulting from climate-related disasters and the costs to insure such infrastructure. Globally, financial losses from climate-related disasters continue to increase, and developing countries bear the greatest brunt of this. These losses can be significant. Aon reported that, in 2022, the global economic loss from natural disasters, including droughts, earthquakes, floods, and cyclones, was about $313 billion (Aon 2022).[14] However, less than half of this amount was insured through disaster-risk

Along with the current unsustainable levels of water consumption, climate change may increase the future cost of providing and accessing bulk water.

insurance programs. During a disaster, this large protection gap would expose many countries to significant fiscal shocks and liquidity constraints.

Currently, although there are no systematic estimates of the spending requirements to insure water infrastructure against shocks, water infrastructure is particularly vulnerable to climate shocks. Investing in disaster insurance programs can help financially protect crucial infrastructure, making it more resilient against disasters while also providing the liquidity that governments need when disasters strike. Overall, investing in infrastructure resilience can yield significant benefits—an estimated $4 for each $1 invested (Hallegatte, Rentschler, and Rozenberg 2019). However, the spending requirements estimated in this chapter do not account for the financing costs of insurance or financial protection.

(iii) ***Our assumptions about WASH options have cost implications.*** Throughout this exercise the assumptions we made for our estimates have several cost-calculation implications, and removing some of those assumptions that could raise WASH spending requirements. For the estimates in this chapter, we selected a mix of lower-cost technology options for basic WASH services (Hutton and Varughese 2016), such as community wells and latrines (albeit improved). We reserved more upscale, higher-cost options, such as piped water and sewerage, for inclusion under safely managed services. However, because of rising aspirations throughout the developing world as ordinary working-class people become more aware of different lifestyles through social media and other internet channels, more and more households are choosing or insisting on piped options to gain even basic-level WASH services. The spending requirements for basic WASH services are therefore likely to be underestimated as governments face pressure to provide more modern and more convenient services.

(iv) ***Countries' technology upgrade paths can profoundly affect their spending requirements.*** The upgrade path that a country selects to modernize its WSS technology to achieve the SDG targets can markedly influence spending costs (Fox et al. 2019). Providing the population with safely managed water and sanitation services in one direct step—one great leap forward—is typically less costly than taking a non-systematic, here-and-there, indirect route that proceeds in a series of *ad hoc* steps, where a country first invests in lower technologies only then to discard them at some point in order to upgrade (Fox et al. 2019; Hutton and Varughese 2016). Infrastructural choices and decisions often have deep path dependency effects; imagine London trying to switch to driving on the right side of the road. The estimates employed in this chapter assumed a conservative approach, in which only 50 percent of the spending requirements for the universal provision of basic water services, and for the elimination of open defecation, were included to account for the hypothetical indirect path taken by the countries to achieve universal safely managed water supply and sanitation coverage in the analysis.

Another path option that can have hidden costs is irrigation for agricultural production. Mitigating policies are sometimes needed to counter the potential adverse effects of irrigation investments, and the costs of those complementary policies are not reflected in the spending requirements (Fox et al. 2019). For example, creating irrigated cropland can increase GHG emissions if forests are converted into cropland. Another very common contributor to GHG emissions is open field burning to clear stubble, and forest burning to create new croplands, fertilize the soil, or eliminate pests (Andela and Van Der Werf 2014; Korontzi et al. 2006; Singh 2022).[15] These costs have not been factored into our estimates.

Over-extraction of groundwater is another cost we did not explicitly consider in our calculations. Expanding irrigation infrastructure can lead to unsustainable levels of water extraction from natural sources such as groundwater and compete with the natural rate of water flow and recharge. In countries like India, Pakistan, Bangladesh, and Sri Lanka, where agriculture competes with other sectors for groundwater, over-extraction is already a significant problem. Hence, policymakers must consider the potential costs of complementary policies and balance the economic benefits of increased agricultural production with the need to mitigate the negative impacts of irrigation investments on the environment and natural resources. The potential costs of such complementary policies were not accounted for in our estimation exercise.

(v) ***Shifts in global macroeconomic conditions can affect water sector spending requirements.*** Changes in global macroeconomic conditions could further limit spending levels in the water sector and thus widen spending gaps. In 2021, for example, the global debt burden reached an all-time high, estimated to be around \$303 trillion, with public or government debt representing close to 40 percent of it.[16] Although debt was already on a rising trend before the pandemic, COVID-19 and the war in Ukraine further exacerbated it (IMF 2022). Rising inflation will additionally aggravate developing countries' global debt (IMF 2022).

Over the last decade or so, low interest rates have greatly facilitated global borrowing, but central banks around the world have begun to raise their interest rates to try to rein in the beginnings of escalating inflation triggered by the pandemic and the war (IMF 2022). Such macroeconomic developments will increase the cost of debt financing for many governments. As a result, governments may be forced to reduce public spending in many sectors, including water. Many emerging market economies and developing countries—the same countries with significant water sector spending gaps—will be severely affected primarily through the rise in the cost of borrowing and loan repayments.

This situation is unsettling for the water sector because it depends so heavily on public spending as its primary source of expenditure. As shown in part 3 chapter 2, public spending on WSS and irrigation decreased during the pandemic in several countries where data are available. Thus, spending gaps in the water sector may widen amid global macroeconomic uncertainties, further complicating the route to achieving the 2030 SDG targets. These challenges too are not captured in this estimation exercise.

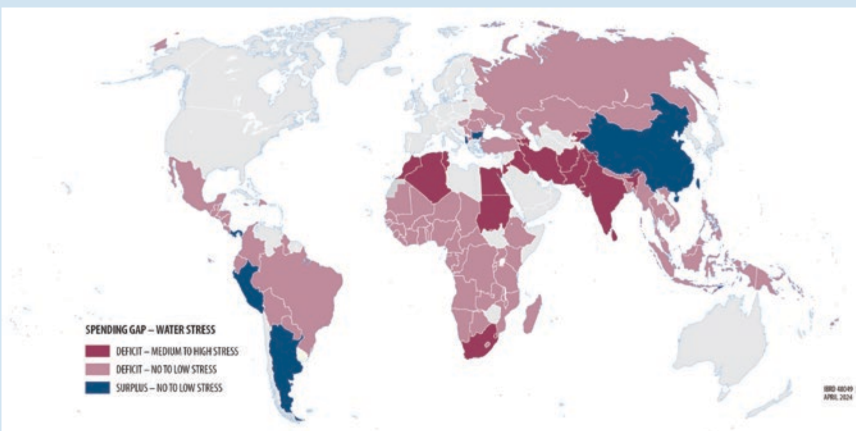
BOX 2.2.2 Achieving SDG 6.1 and 6.2: The Many Costs of Climate-Induced Water Stress

Access to clean water is essential for achieving sustainable development, a tenet encoded in SDG targets 6.1 and 6.2. However, as argued in this chapter, the spending gaps for achieving these targets are likely to be underestimated, and one reason for this is the likely increase in the future costs of storing and distributing water (Hutton and Varughese 2016)—in particular, the cost of piped water supply services.

Climate change is expected to reduce renewable surface water and groundwater resources, especially in dry subtropical countries. For every degree rise in average global temperature, an additional 7 percent of the global population will be exposed to at least a 20 percent reduction in renewable water resources (Jiménez Cisneros et al. 2014). In many countries, this could raise the freshwater withdrawal rates and increases the risk for water stress. By 2040, it is estimated that as many as 33 countries could, as a result of climate change, experience extremely high levels of water stress (Luo, Young, and Reig 2015).

By overlaying the available data on 2019 water stress levels onto the estimated spending gaps for each available country, we found that 18 countries included in our earlier analysis—among them India, Sri Lanka, Pakistan, Jordan, Morocco, and South Africa—are experiencing both medium to high levels of water stress and spending shortfalls to achieve the SDG targets by 2030. Water stress or water scarcity incur additional costs and will likely further widen the spending gaps in these countries.

MAP B2.2.2.1 Country-Level Cross Map between Spending Gaps to Achieve SDGs 6.1 and 6.2, and Water Stress Conditions



Note: SDG = Sustainable Development Goal.

When freshwater is scarce, providing water services is typically more difficult and expensive. Additional infrastructure often needs to be in place for water utilities to store, transport, and treat water to maintain a suitable level of piped water service. For example, water may need to be extracted from harder-to-access, more energy-intensive resources such as deeper underground aquifers (Shamsudduha et al. 2020). Furthermore, when renewable water sources like groundwater approach depletion levels, the water quality tends to decline, raising the cost of treating it (Konikow and Kendy 2005). Alternatively, infrastructure investments may need to be made to bring in water from a different region or to build rainwater storage facilities and desalination plants.

box continues next page

BOX 2.2.2 Achieving SDG 6.1 and 6.2: The Many Costs of Climate-Induced Water Stress (*Continued*)

In addition, maintenance costs could increase. When water utilities are forced to supply water intermittently, it tends to shorten the lifespan of pipelines because abrupt changes in flow and pressure in pipelines stress and weaken them over time (Haider et al. 2022; Schmitt et al. 2006; Zhang and MIT 2017). The mix of air and water in a pipe carrying an intermittent supply can also cause corrosion by exposing it to moist air (Lee and Schwab 2005) and facilitating the growth of corrosion-causing microbial biofilms (Bautista-de los Santos, Chavarria, and Nelson 2019; Kumpel 2013; Teng, Guan, and Zhu 2008; Yang et al. 2022).

In summary, achieving the SDG 6.1 and 6.2 will require significant investments in infrastructure and maintenance, but this is especially true in countries facing high water stress or scarcity. As climate change continues to impact water resources, these costs will likely increase.

Notes

1. The Sustainable Development Goals were adopted on September 25, 2015 by the 193 member-countries of the UN General Assembly as part of its Post-2015 Development Agenda.
2. Globally, between 2015 and 2022, access to safely managed water services and sanitation services improved from 70 to 73 percent, and from 47 to 57 percent, respectively. Average annual rates of progress were roughly 0.4 percentage points and 1.4 percentage points, respectively (WHO and UNICEF 2023).
3. Kuwait, Monaco, and Singapore are the only countries that had achieved universal access to safely managed sanitation and water services by 2020.
4. One DALY represents the loss of the equivalent of one year of full health.
5. The WHO recommends practicing continual hand hygiene to prevent the transmission of the COVID-19 virus. See WHO, "Transmission of SARS-CoV-2: implications for infection prevention precautions," July 9, 2020, https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions.
6. The expected increase in energy consumption may vary regionally, with the largest increase expected to come from the Middle East, driven by the energy demand from water desalination processes.
7. Ethiopia, Nigeria, and Tanzania account for almost 30 percent of Africa's estimated untapped agricultural potential (Goedde, Ooko-Ombaka, and Pais 2019).
8. A basic water supply is an improved source that is within a 30-minute roundtrip of the user, and basic sanitation refers to the use of improved sanitation facilities that are not shared with other households. A basic handwashing facility is defined by a device to contain, transport, or regulate the flow of water to facilitate handwashing with soap and water in the household.
9. When the analysis was conducted, Guinea was included. As of June 2023, Guinea has been revised to a lower-middle income country.
10. For a more detailed description of their methodologies, please see Rozenberg and Fay (2019).
11. Due to data limitations, we were unable to compute the spending requirements at the regional level using a bottom-up approach by first estimating the spending requirements at the country level, as was done in the preceding chapter with the WSS subsector.

12. As discussed in an earlier footnote, the SA region is particularly agriculture-intensive based on the sector's value added as a share of regional GDP (World Bank 2021). One reason the average irrigation spending is relatively low could be because data for India, Sri Lanka, and Nepal were not available.

13. In the latest JMP report, it is estimated that the rate of progress required to achieve SDG targets between 2022-2030 will need to increase between 3 to 6 times the rate of progress between 2015 and 2022. This also indicates that the rate of progress has not improved between the reports (2020–2022) (WHO and UNICEF 2023).

14. According to Aon, this figure is close to the average annual costs of disasters for the century.

15. See also CCAC, "Open agricultural burning," Climate & Clean Air Coalition, December 6, 2018, https://www.ccacoalition.org/en/activity/open-agricultural-burning.

16. Estimates provided by the International Institute of Finance (IIF). See Tommy Wilkes, "Emerging markets drive global debt to record $303 trillion – IIF," *Reuters*, February 23, 2022, https://www.reuters.com/markets/europe/emerging-markets-drive-global-debt-record-303-trillion-iif-2022-02-23; and Victoria Masterson, "What does 'global debt' mean and how high is it now?" *World Economic Forum*, May 16, 2022, https://www.weforum.org/agenda/2022/05/what-is-global-debt-why-high.

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PART 3

LIQUID LEDGER

Dissecting the Anatomy of Water Spending

CHAPTER 3.1

Money, Whence it Came, Where it Went?

KEY MESSAGES

- Direct government spending constitutes about 85.5 percent of total spending in the water sector. The private sector contributes less than 2 percent.
- From 2009 to 2020, public spending in the water sector constituted only about 1.2 percent of total government spending, significantly lower than spending in other infrastructure sectors such as transport and energy.
- In 2017, almost 80 percent of water supply and sanitation (WSS) infrastructure investments came from public entities (national and local governments), 11 percent from SOEs, and about 9 percent from the private sector.
- Public–private partnerships (PPPs) in infrastructure are often proposed as the bridge for the global infrastructure gap, yet between 2009 and 2020, only about 3.1 percent of total PPP infrastructure investment went into WSS.
- Between 2009 and 2020, capital spending accounted for almost two-thirds of public spending in the water sector, far outstripping recurrent spending and dwarfing the share of maintenance spending (capital maintenance and recurrent maintenance spending).
- Domestic sources funded 64 percent of water sector public spending.

Introduction: Sources of Spending in the Water Sector

As shown in part 1, the water sector plays a pivotal role in driving economic growth, fostering human capital development, and ensuring sustainable living on the planet. Several unique characteristics of water make its management and financing challenging and set it apart from other resources and services. Water-related investment needs are also multifaceted. They range widely from water abstraction and storage to wastewater treatment and urban drainage, from the provision of drinking water and flood protection to irrigation and hydropower (Jiang 2023). These investment needs go beyond the construction of physical infrastructure and extend to maintenance, management, governance, and capacity development (Jiang 2023). Given the challenge of managing and financing the sector's investment needs, underinvestment (part 2 chapter 2) has left many developing countries wrestling with inadequate water infrastructure and services, especially in urban slums and in rural or underserved regions. Although government plays a predominant role in the sector, other sources of spending and modes of service provision try to meet the sector's multidimensional demands.

Spending in the water sector has four main sources: (i) Public spending through government budgets, (ii) public spending through SOEs, (iii) private sector spending, excluding households, and (iv) official development assistance (ODA).

The main service delivery institutions that involve public resources are public entities (governments), SOEs, and PPPs. Public entities include national or federal governments, along with local or subnational governments of various tiers. SOEs are firms or public utilities, wholly or majority-owned by governments, that participate in the market on the government's behalf, usually with a specific social, political, or economic mandate such as improving access to electricity or water services. Together, public entities and SOEs make up the public sector. PPPs are collaborative arrangements between a government entity and a private sector organization. They are often presented as an alternative policy vehicle, governments could leverage to finance water sector infrastructure developments, but this promise has not yet materialized.

This chapter looks at the four sources of spending in the water sector to uncover trends and patterns in infrastructure spending and investment. Data on spending by public entities are available from the BOOST database, which, as explained in previous chapters, contains budget data from national and sometimes subnational governments. An advantage of using the BOOST data is that it allows the decomposition of spending into various categories by source—domestic or foreign—as well as by functions (capital or recurrent) and further subcomponents. This chapter examines BOOST data on 68 countries from 2009 to 2019.[1]

It also drew on the World Bank's combined SPI–PPI database for data on project-level infrastructure investments by SOEs and the private sector, including PPPs.[2] The SPI-PPI database reports commitments rather than actual investments by using project-level data available from various outlets, including news media, and hence has limitations in terms of accuracy and comprehensiveness. It should also be borne in mind that nearly all the data on water sector spending available in the Private Participation in Infrastructure (PPI) and SPI databases are confined to the water supply and sanitation (WSS) subsector. Though the three databases—BOOST, SPI, and PPI—are not 100 percent apples-to-apples comparable, employing all three offers a comprehensive overview of the patterns and volume of spending among the three categories of service providers, where public spending is directly or indirectly involved.

Based on the analysis on fiscal and project-level data, the total annual spending in the water sector globally in 2017 is estimated to be $164.6 billion. This includes fiscal spending by public entities, project-level spending by SOEs and the private sector, and ODA. Of this, 85.5 percent ($140.7 billion) is government fiscal spending, 6.93 percent is ODA, 5.90 percent comes from SOEs, and 1.68 percent is from the private sector which also include PPPs.

BOOST data show that, between 2009 and 2020, on average, government spending on the water sector constituted about 1.2 percent of total government spending for the 68 countries in this analysis. This includes four subsectors—water supply and sanitation (WSS), irrigation, hydropower, and water transport. As expected, total *capital* spending constituted a much larger share than total *recurrent* spending. This was true for most subsectors. Of the total recurrent expenditure, both capital maintenance and recurrent maintenance are significantly low. This is disconcerting. True to the old adage, "A stitch in time saves nine," regular, systematic maintenance of water infrastructure can reduce its total lifecycle cost by more than 50 percent (Rozenberg and Fay 2019).

The total annual spending in the water sector globally in 2017 is estimated to be $164.6 billion.

Additionally, the public sector is the primary driver of infrastructure development in the water sector. Based on project-level information from the World Bank's SPI–PPI database, infrastructure investments in WSS from all sources amounted to $20.2 billion in 2017, with the public sector accounting for almost 91 percent of this. Within the public sector, almost 80 percent of WSS infrastructure investments came from public entities in 2017, and an additional 11 percent from SOEs. Just 9 percent ($1.8 billion) was from the private sector (a combination of PPPs and exclusively private investment).

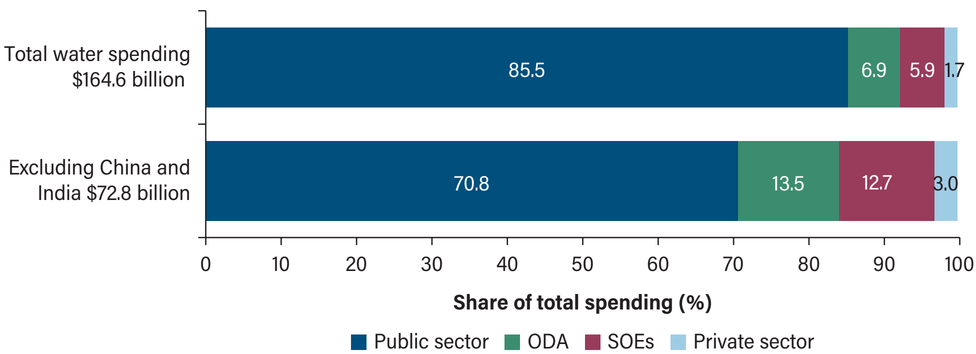
Public spending in the water sector tends to be associated with economic growth. Using a series of regressions, we found that per capita spending in the water sector tends to increase, albeit less than proportionately, with an increase in GDP per capita. This is not entirely like per capita spending for the infrastructure sector overall, and especially for the transportation sector, such where increases in GDP per capita are associated with more than proportionate increases in spending. In other words, public spending in the water sector tends to grow at a slower rate than economic growth, and at a slower rate than it does in the infrastructure sector, generally.

To offer a quick summary of the next four sections of this chapter, the study first estimates the total spending in the water sector from all the four sources mentioned above. In the next section, it presents findings on the patterns of public spending from the fiscal data obtained from the BOOST database. This is based on a subset of 68 countries for which water sector fiscal spending data were available. The third section examines infrastructure investments in the water sector from SOEs and the private sector, including PPPs, from project-level information obtained from the SPI–PPI database. In the fourth section, using a series of regression analyses, the study examines the correlates of public spending in the water sector.

Spending from All Sources

Based on the data available from all sources—fiscal and project-level data—the total annual spending in the water sector globally in 2017 is estimated to be $164.6 billion. This includes fiscal spending by public entities, project-level spending by SOEs and the private sector, and ODA. The estimated total water sector spending covers spending in WSS, irrigation, water transportation and hydropower. As shown in figure 3.1.1, most of the spending in the water sector is from the public sector, including both fiscal spending by public entities and SOEs. Of this, 85.5 percent ($140.7 billion) is government fiscal spending. This is followed by ODA[3] (6.93 percent), SOEs (5.90 percent), and the private sector (1.68 percent). To put this spending into perspective, global military spending in 2017, at $1.74 trillion, is more than 10 times larger than the estimated global spending on the water sector that same year (SIPRI 2018).

FIGURE 3.1.1 **Share of Water-Sector Spending, by Source**



Source: Authors' calculation based on BOOST, SPI–PPI and CRS database.
Note: (i) Water spending by government (public sector) is calculated based on the lower-bound estimates from part 2 chapter 1, "Magnitude and Trends in Public Spending in the Water Sector"; (ii) Spending by the state-owned enterprises (SOEs) and private sector, excluding households from 2008 to 2017, was calculated from the SPI–PPI database; (3) Official development assistance (ODA) in this analysis includes other official flows.

Spending by China and India from all sources makes up more than half of the spending in the water sector. Excluding the two countries, annual spending in the water sector falls to $72.8 billion. This finding is again unsurprising and resonates with earlier findings in part 2 chapter 2, that China and India—which together have more than one-third of the earth's GDP, about 2.9 billion people—contribute a large portion of the spending in the global water sector.

PUBLIC SECTOR SPENDING

Altogether, public sector spending (public entities plus SOEs) made up about 91.4 percent of the estimated total spending in the water sector in 2017, corresponding to about $150.4 billion ($140.7 billion + $9.71 billion). By itself, fiscal spending by public entities (that is, national, federal, and local governments) makes up the largest share of total spending in the sector, at 85.5 percent (about $140.7 billion). Again, this number is the lower-bound water sector spending that was estimated in part 2 chapter 1 of this study.

It should be noted that the estimated spending by SOEs only reflects their infrastructure investments since the SOE data were derived from the SPI–PPI database, which does not include information on other forms of spending, such as recurrent spending. Roughly 5.90 percent (about $9.71 billion) of total global water spending in 2017 came from SOEs. Excluding China and India, the share of SOEs increases to 12.7 percent ($9.22 billion). In other words, most of the available data on SOE spending in the water sector (which is also predominantly in the WSS sector) occurs outside of China and India.

In 2017, private sector investments made up only about 1.68 percent of the total annual spending in the water sector.

OFFICIAL DEVELOPMENT ASSISTANCE

ODA refers to financial aid or resources provided by governments or international organizations to support the economic development and welfare of developing countries (box 3.1.1) ODA is often given as grants or low-interest loans and are intended to support the development priorities and needs of the recipient countries. The analysis above shows that ODA plays a rather important role in the development of the water sector. In total, ODA makes up to about 6.93 percent or $11.4 billion of the total water sector spending. Excluding China and India, ODA makes up an even larger share at 13.5 percent or $9.79 billion of the total water sector spending.

PRIVATE SECTOR SPENDING

While private sector investments are often presented as a solution to bridging the infrastructure investment gap in the water sector, their participation at present is minimal. In 2017, employing available data from the SPI–PPI database, private sector investments made up only about 1.68 percent (3.04 percent if China and India are excluded) of the total annual spending in the water sector, corresponding to about $2.77 billion ($2.21 billion excluding China and India). This figure includes both the cost of documented water sector projects fully owned by private entities, and the value of private sector investments among documented PPPs in the water sector.

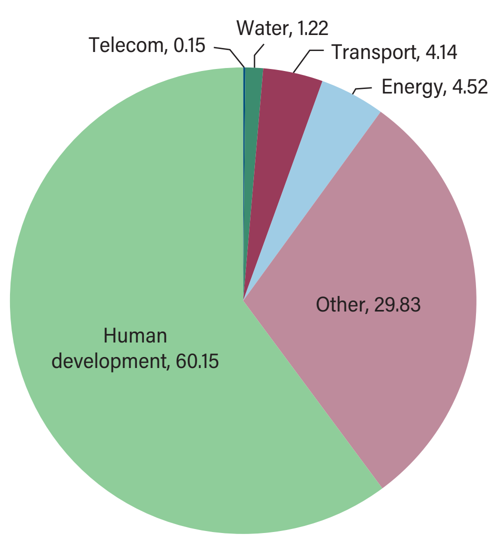
Trends and Characteristics of Spending by Public Entities

In this section, we examine the trends of public spending by national and (when available) subnational governments in the water sector. The analyses in this section were conducted using fiscal data available from the BOOST database between 2009 and 2020s. Because of data availability constraints, they include a smaller subset of 68 countries.

OVERALL PUBLIC SPENDING IN THE SECTOR

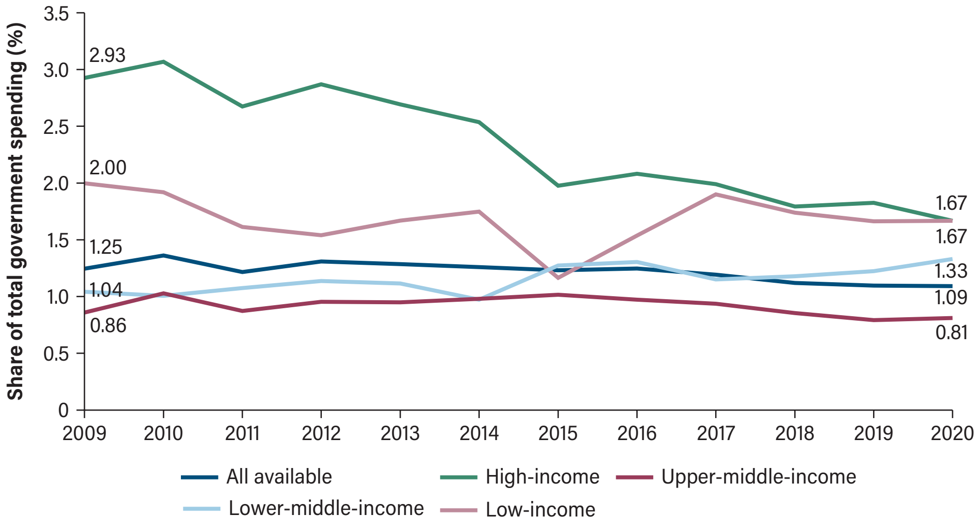
On average, fiscal spending by governments in the water sector constitutes about 1.22 percent of total government spending between 2009 and 2020 for the countries included in this analysis (n = 68) from the BOOST database (figure 3.1.2). This includes four subsectors—water supply and sanitation (WSS), irrigation, hydropower, and water transport.[4] Based on the period studied, the share of public spending in the water sector was relatively small compared to the other sectors that were available for comparison, such as transport, energy, and the human development (which comprises education, health, and social protection). Additionally, over the last decade, public spending in the water sector has largely remained stable (figure 3.1.3), especially when excluding the high-income countries in the sample (N=7).[5] The detailed methodology and a summary of statistics are reported in appendix C.

FIGURE 3.1.2 Spending in the Water and Other Sectors as a Share of Total Government Spending, Pooled Average, 2009–20



Source: Authors' elaboration using BOOST database. All public expenditure data in this analysis are based on original BOOST data and on linear interpolation to fill up the missing values of earlier years.

FIGURE 3.1.3 Weighted Average of Water Sector Spending as a Share of Total Government Spending, by Country Income Level, 2009–20



Source: Authors' elaboration using BOOST database.

PUBLIC SPENDING BY SUBSECTOR

Drilling down to water's subsectors, the data indicates that, between 2009 and 2020, the share of public spending in the WSS sector remained stable and constituted about 75 percent of total public spending in the water sector (figure 3.1.4). This was followed by public spending on water transport (15.9 percent), irrigation (7.5 percent), and hydropower (1.5 percent).[6]

FIGURE 3.1.4 Relative Shares of Public Spending in Water Sector for All Available Countries, 2009–20, by Subsector

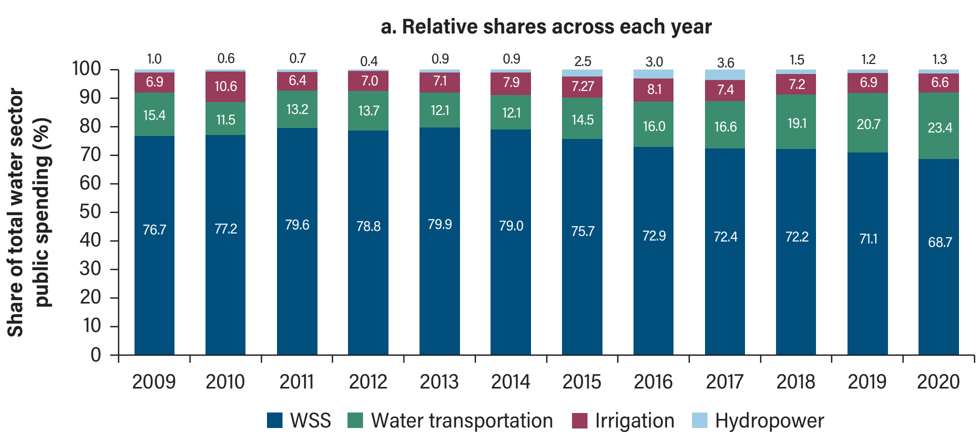


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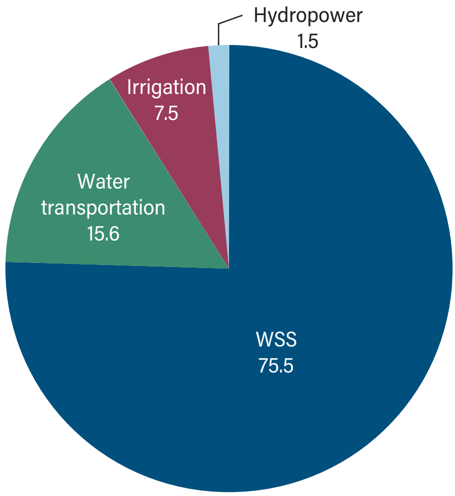
FIGURE 3.1.4 Relative Shares of Public Spending in Water Sector for All Available Countries, 2009–20, by Subsector (*Continued*)

b. Weighted average

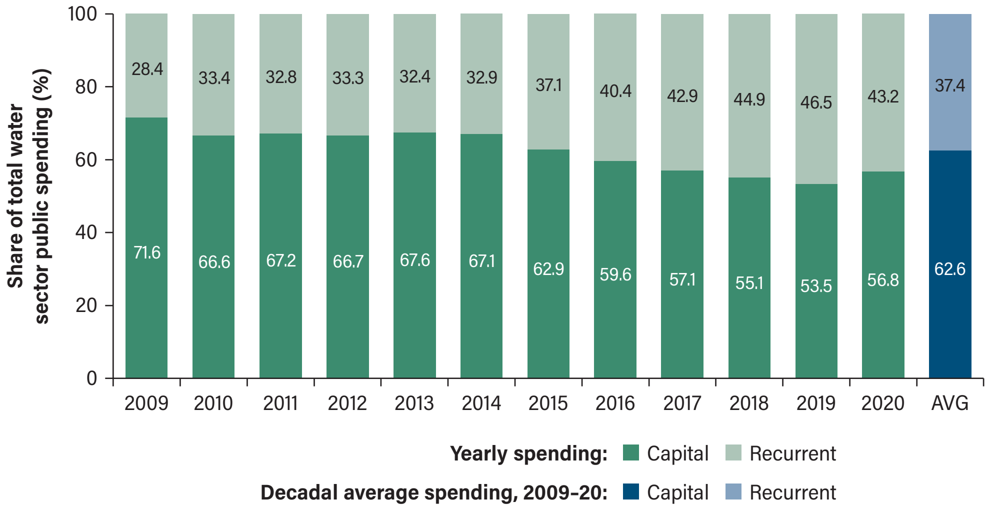


Source: Authors' elaboration using BOOST database.
Note: WSS = water supply and sanitation.

TYPES OF SPENDING: CAPITAL AND RECURRENT

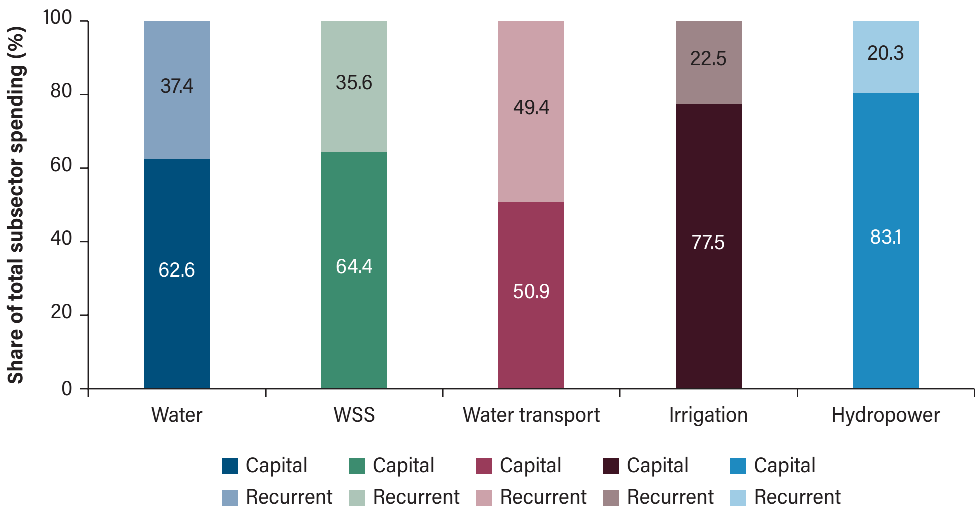
Capital spending was larger than recurrent spending between 2009 and 2020 (figure 3.1.5), constituting almost two-thirds of public spending. The share of capital spending in the water sector, however, declined from 71.6 percent in 2009 to about 56.8 percent in 2020. Considering that total spending in the water sector during this period had remained relatively stable, this reduction in the share of capital spending may indicate declining infrastructure development in the sector. Even if spending on recurrent expenditure such as maintenance may be increasing, decreasing share of capital expenditure would be an unsettling trend in light of the large spending gaps to achieving the sector's Sustainable Development Goals (SDG) targets, as highlighted in part 2 chapter 2. Among the subsectors, capital spending seems to be highest in the hydropower subsector and lowest in water transport (figure 3.1.6), indicating the relative differences in capital intensity among the various subsectors.

FIGURE 3.1.5 Relative Shares of Capital and Recurrent Spending in the Water Sector, 2009–20



Source: Authors' elaboration using BOOST database.

FIGURE 3.1.6 Weighted Average of Capital and Recurrent Spending, by Subsector, 2009–20



Source: Authors' elaboration using BOOST database.
Note: WSS = water supply and sanitation.

COMPOSITION OF RECURRENT SPENDING

Between 2009 and 2020, the share of recurrent spending that went into paying wages and maintenance costs in three subsectors—WSS, water transport, and irrigation— was relatively small (figure 3.1.7). It is troubling that maintenance spending remained so low during that period because it is a crucial step in sustaining the condition and functioning of physical infrastructure. Regular maintenance generates substantial savings that in some instances can reduce the total life-cycle cost of WSS infrastructure by more than 50 percent (Rozenberg and Fay 2019). Indeed, WASH Poverty Diagnostic exercises[7] carried out by the World Bank have demonstrated that poor maintenance is a key reason many water points in rural communities have failed. Examples include instances in Nigeria and Tanzania (Andres et al. 2018; Joseph et al. 2019). Furthermore, as discussed in part 2 chapter 2, with climate change, the financial requirements for maintaining water infrastructure could increase especially due to increases in energy and storage requirements, as well as, increased severity of climate extremities that can cause damage to water infrastructures.

FIGURE 3.1.7 Total Recurrent Spending, Recurrent Wage Spending, and Capital and Recurrent Maintenance Spending as a Share of Total Public Spending in the WSS, Water Transport, and Irrigation Subsectors, 2009–20

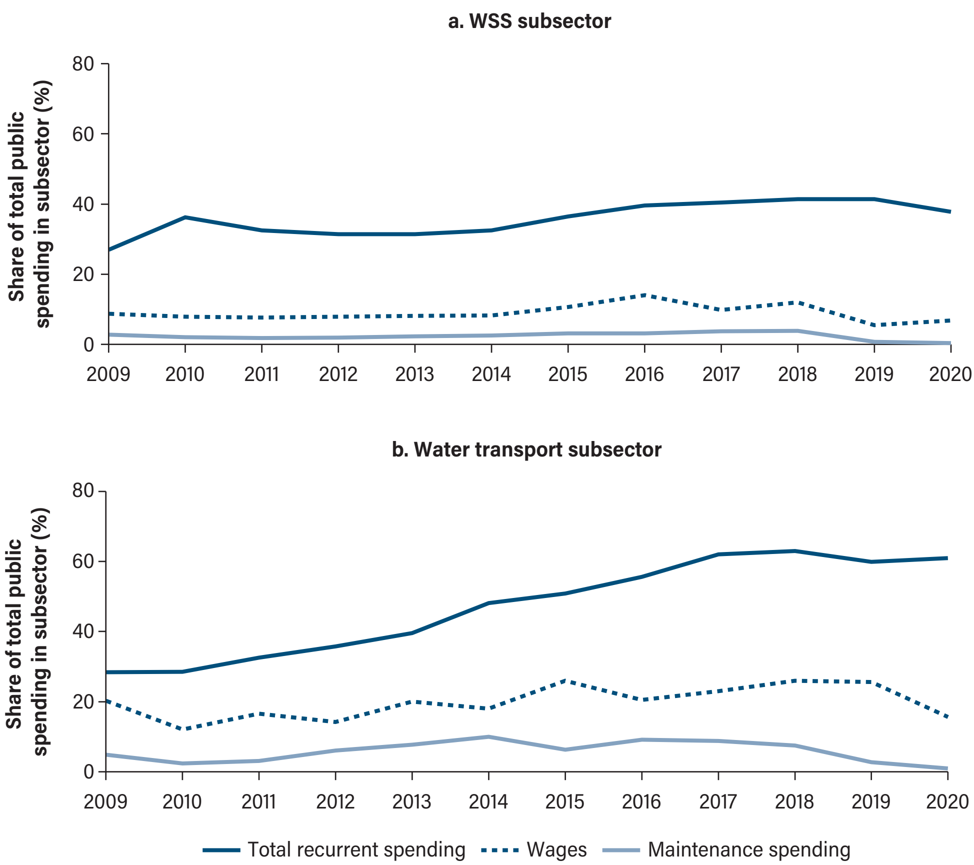


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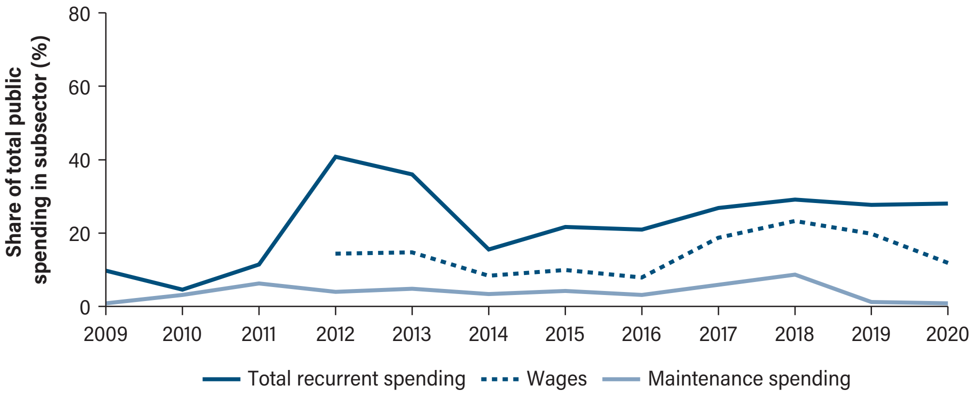
FIGURE 3.1.7 Total Recurrent Spending, Recurrent Wage Spending, and Capital and Recurrent Maintenance Spending as a Share of Total Public Spending in the WSS, Water Transport, and Irrigation Subsectors, 2009–20 (*Continued*)

c. Irrigation subsector

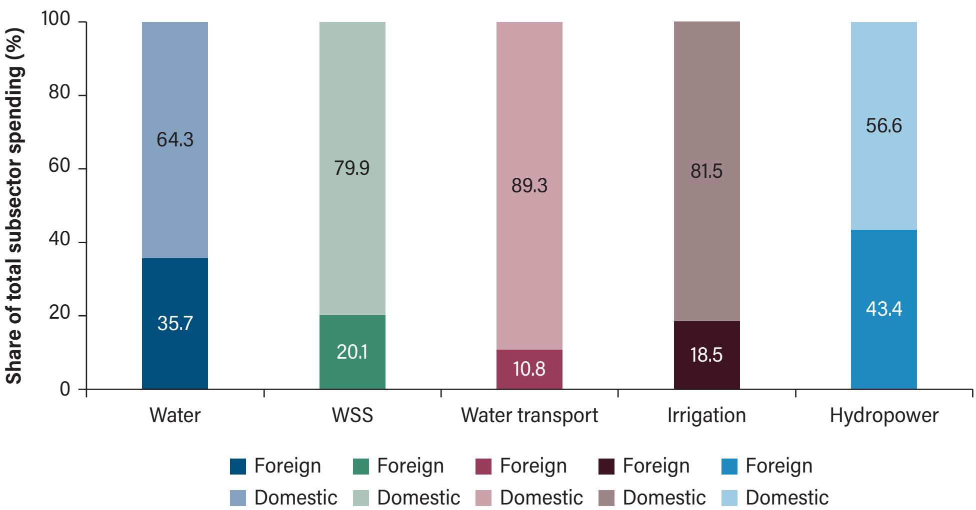


Source: Authors' elaboration using BOOST database.
Note: Recurrent spending has several other components, which are not represented in the figure. WSS = water supply and sanitation.

SOURCES OF FUNDING: FOREIGN AND DOMESTIC

Between 2009 and 2020, 64 percent of the public spending in the water sector came from domestic sources—tax revenue, utility tariffs, and budgetary transfers—rather than foreign sources (figure 3.1.8). In contrast, in the hydropower subsector, funding came mainly from ODA sources.

FIGURE 3.1.8 Relative Share of Domestic and Foreign Funding Sources, in the Water Sector, Weighted Average, 2009–20



Source: Authors' elaboration using BOOST database.

Contribution by ODA in the Water Sector

As shown earlier, ODA is the second-largest source of spending in the water sector and a significant contributor to the sector's development. ODA (which includes OOF in our analysis) consists mainly of official bilateral transactions intended to promote development, such as technical assistance and capacity building, that help support development efforts (box 3.1.1). Between 2011 and 2019, ODA flows into the water sector accounted for only about 5 percent of total ODA (figure 3.1.9). Over this nine-year period, the total ODA flows into the sector amounted to about $105.3 billion, or about $11.7 billion annually. Within the water sector, the WSS subsector received by far the most ODA (58 percent of total water sector ODA), followed by WRM and to a lesser extent, water transport, agricultural water resources (that is, irrigation) and hydropower during this period.

BOX 3.1.1 Overseas Development Assistance: Trends and Patterns

ODA is foreign aid that takes the form of (i) bilateral financial assistance from the governments of donor countries, or (ii) low-interest loans and grants from multilateral financial institutions, provided to support the economic development and welfare of developing countries.

Closely related to ODA is OOF (other official flows), official sector grants that do not fully meet the criteria for ODA. In the analyses presented this study, ODA is treated as including OOF.[9] OOF consists of grants for representational[10] or essentially commercial purposes; official bilateral transactions intended to promote development but having a grant element of less than 25 percent; and official bilateral transactions, whatever their grant element, that are primarily export-facilitating in purpose.[11] In 2019, ODA to all developing countries amounted to about $192.2 billion, and OOF about $68.8 billion, together totaling $261 billion, in current dollars.

Guided by criteria such as effectiveness, transparency, accountability, and alignment with the recipient country's development goals, ODA is typically provided to promote sustainable development, reduce poverty, improve infrastructure, build capacity, offer technical assistance, offer debt relief, enhance education or healthcare systems, or in some cases in response to humanitarian causes such as refugee crises, genocides, or military invasions.

In 2022, the ten-largest ODA donors in dollar terms were the United States, Germany, the EU, Japan, France, the United Kingdom, Canada, the Netherlands, Italy, and Sweden, in that order. As a share of their gross national income, the ten-largest donors were Luxembourg, Sweden, Norway, Germany, Denmark, the Netherlands, Ireland, Finland, Sweden, and France (OECD 2024).

A significant source of funding for developing countries, ODA (including OOF) averaged $234 billion a year between 2011 and 2019. During this period, however, net foreign development aid fell slightly in most regions, both as a share of GDP and as a share of total government expenditure. In the MENA region, however, net ODA more than doubled—from less than 1 percent of MENA GDP to more than 2 percent, and from less than 3 percent of MENA recipient government spending to 7 percent. Among the regions, however, Sub-Saharan Africa consistently received the highest ODA, accounting for 3 percent of its GDP and 12 percent of its government expenditure. EAP received the second-highest ODA contributions in absolute terms. Given the size of EAP's GDP and public spending, however, the ODA inflows as a share of regional GDP and government spending were relatively low.

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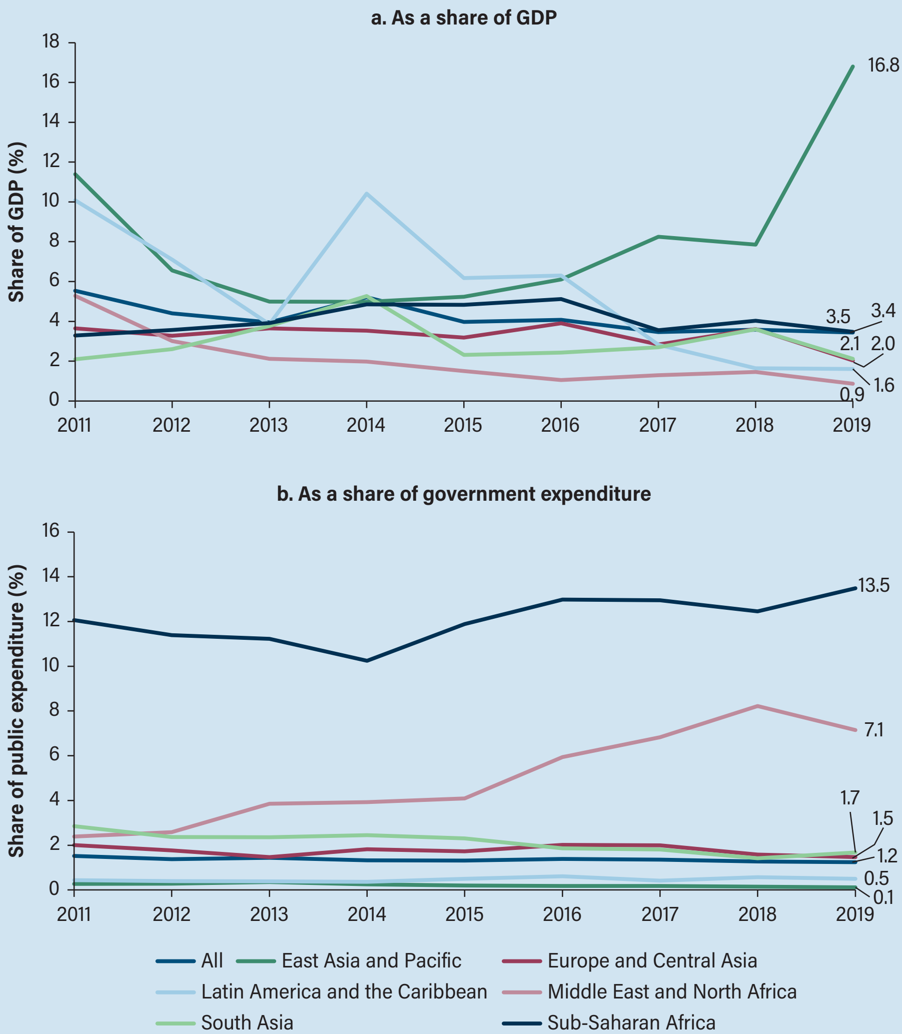
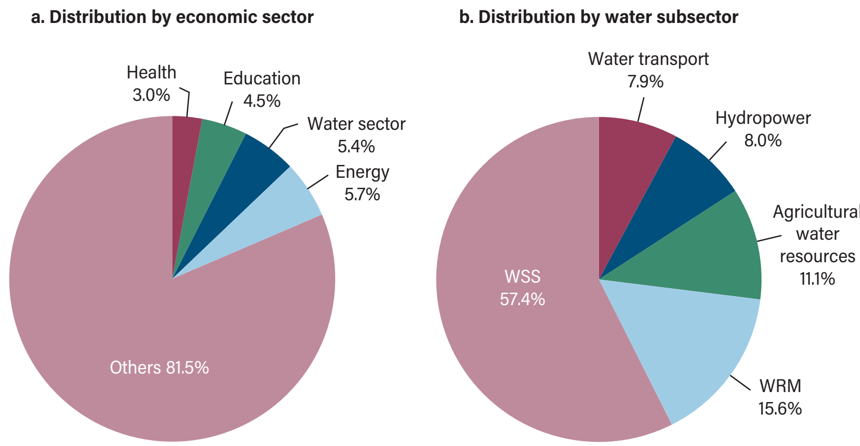
BOX 3.1.1 Overseas Development Assistance: Trends and Patterns (*Continued*)

FIGURE B3.1.1.1 Weighted Average of Total Net ODA, by Region, 2011–19



Source: Authors' elaboration using net ODA data from WDI and government expenditure data from Fiscal monitor database from IMF.
Note: ODA = official development assistance; WDI = World Bank Development Indicator.

FIGURE 3.1.9 Distribution of ODA by Sector and by Water Subsector, 2011–19



Source: Authors' elaboration using BOOST database. ODA includes OOF.
Note: ODA = Official Development Assistance; CRS = Credit Reporting System; OOF = other official flows; WSS = water supply and sanitation; WRM = water resources management.

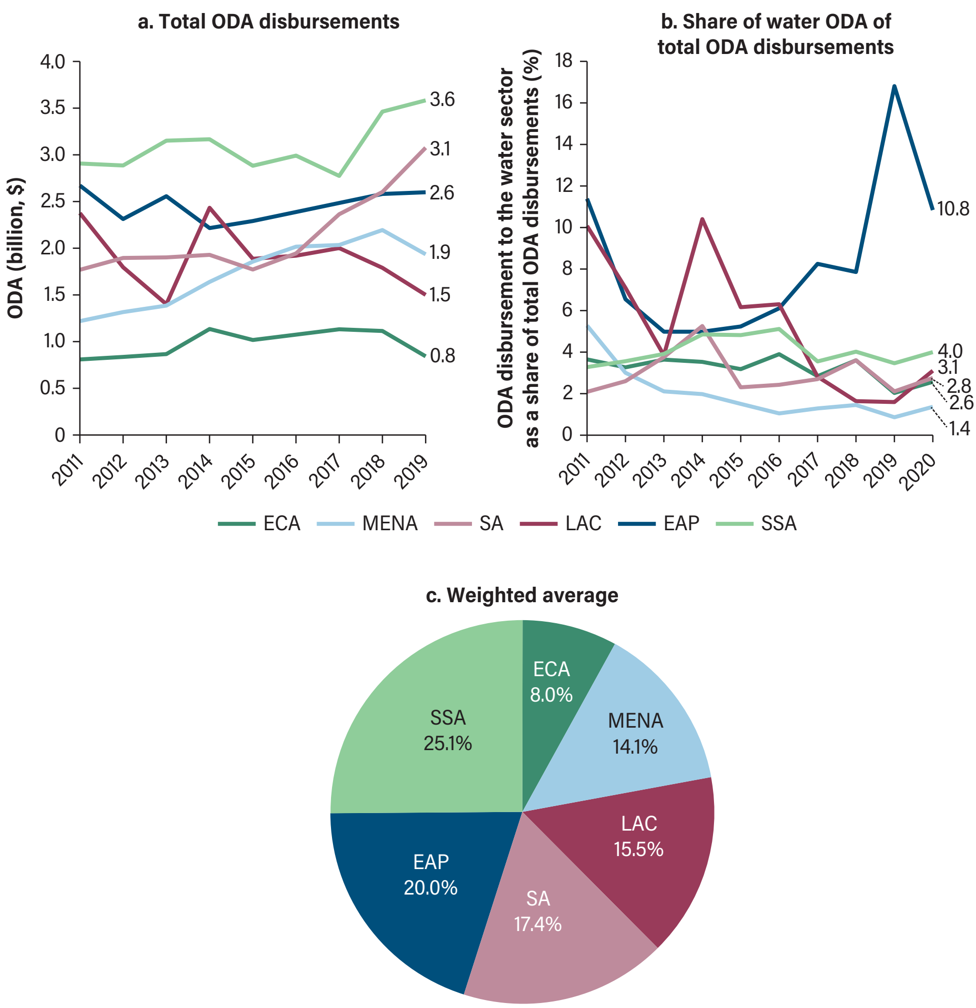
Regionally, SSA received the largest flow of ODA into its water sector, consistently averaging over $3 billion a year from 2011 to 2019, followed by EAP ($2.5 billion) and South Asia (SA) ($2.1 billion), where it steadily increased over the decade. Europe and Central Asia (ECA) received the least ($1 billion) (figure 3.1.10 Panel a).

The dynamics of water ODA as a part of total ODA allocations cast a spotlight on the fluctuating emphasis on water sector investments, albeit in some regions. EAP saw pronounced volatility, culminating in a significant surge in its ODA share in 2019. In contrast, the SSA region maintained a relatively stable yet consistently high level of ODA share throughout the period, reflecting a sustained focus on water sector improvements. Other regions, such as SA and LAC, showed moderate fluctuations, while MENA and ECA experienced more subdued changes in their ODA shares, indicating varied regional development agendas and investment priorities in water infrastructure and services (figure 3.1.10 panel b). From 2010 to 2019, Sub-Saharan Africa (SSA) received the largest share of the total water sector ODA, at 25.1 percent (figure 3.1.10 panel c). Meanwhile, the East Asia and Pacific (EAP) region also received a substantial proportion, accounting for 20.0 percent of the total water-related ODA during this period.

In terms of sectors, the WSS received the lion's share of the water sector ODA, and this was true for all regions. For example, in SSA, 56 percent of total water sector ODA ($15.7 billion out of $27.8 billion) went to WSS over the period. The share of ODA that went to the WSS subsector was highest in LAC, at about 70 percent of total water sector ODA (figure 3.1.11).

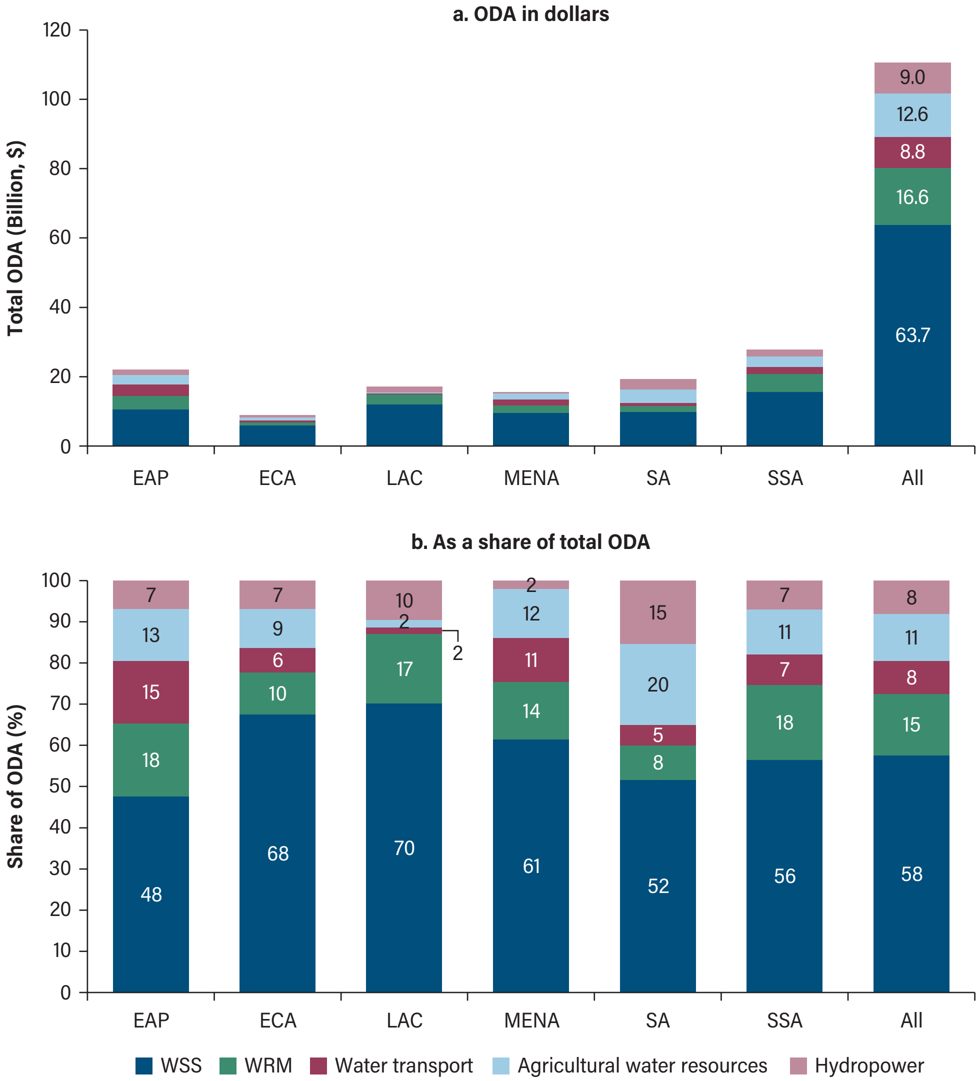
Between 2011 and 2019, most ODA to the water sector came from the OECD Development Assistance Committee (DAC) countries[8] and from multilateral development organizations (figure 3.1.12). On average, multilaterals contributed $6.9 billion (55 percent of the ODA) a year to the water sector, with the DAC countries averaging $5.4 billion (43 percent of the ODA) a year. In 2011, the multilateral–DAC contribution ratio was nearly equal—about 47:52—but in recent years, there has been a slight decrease in DAC contributions and an increase in multilateral contributions. In 2019, the ratio was about 61:37 multilateral to DAC.

FIGURE 3.1.10 ODA Disbursements to the Water Sector, by Region, 2011–19



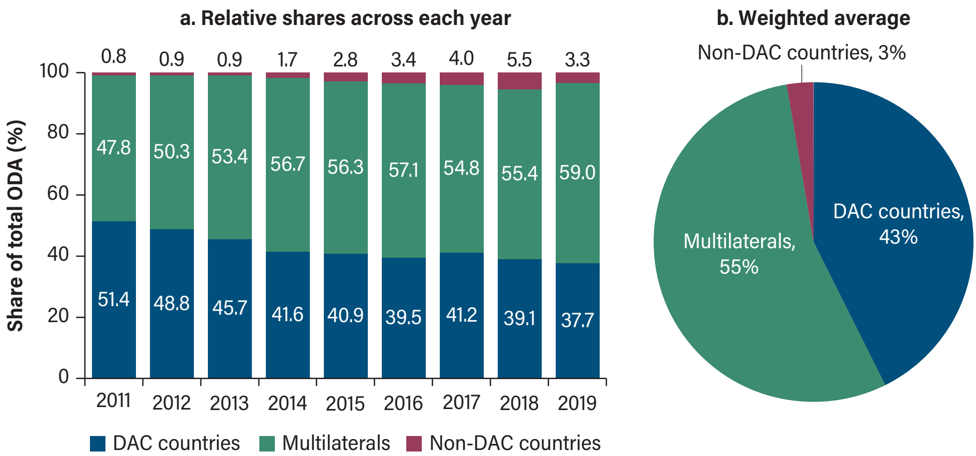
Source: Authors' elaboration using CRS database, and all ODA figures presented in this figure include OOF.
Note: The bottom panel shows the total water ODA in each region as a share of total water ODA. ODA = official development assistance; CRS = Credit Reporting System; OFD = official development flows; EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa.

FIGURE 3.1.11 **ODA to Water Subsectors, by Region, 2011–19**



Source: Authors' elaborations using CRS database.
Note: ODA = official development assistance; CRS = Credit Reporting System; EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa; WSS = water supply and sanitation; WRM = water resources management.

FIGURE 3.1.12 Relative Contributions of ODA to Water Sector, by Donor, 2011–19



Source: Authors' elaboration using CRS database.
Note: ODA = official development assistance; CRS = Credit Reporting System; DAC = development assistance committee.

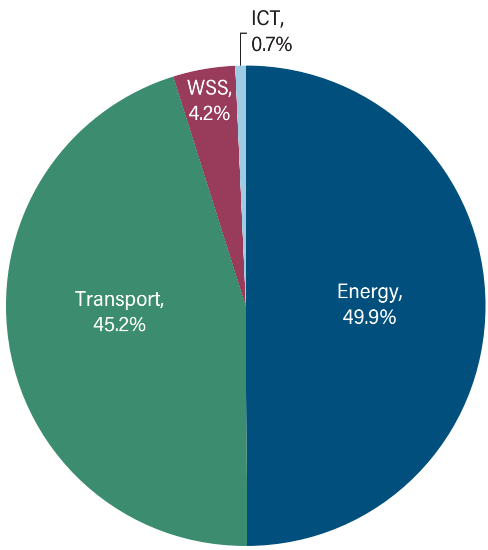
Infrastructure Investments by Public Entities, SOEs, and the Private Sector

SOE INVESTMENTS

This section looks at trends in infrastructure investment in the water sector by public entities, SOEs, and the private sector, and compares them to parallel investments in other sectors where possible, using the SPI–PPI database, which includes information on project-level investments in the infrastructure sectors. The value of infrastructure investment in the database is defined as the investment commitment to an infrastructure project recorded at a stage at which construction for the project can begin after all conception, planning, documentation, contracts, financing (if any) and alignment of counterparties and contractors have concluded. However, it should be noted, that since the database covers only project-level infrastructure spending, significant underreporting is possible, particularly for the public entities and SOEs. Also, in the context of public spending by governments, the project-level infrastructure investments would represent a subset of the total spending since public spending would also cover other forms of expenditure such as recurrent and maintenance spending, as reported earlier in this section.

In 2017, project-level infrastructure investments from all sources in all sectors amounted to $485 billion.[12] Most infrastructure investments (95 percent by dollar volume) were concentrated in the energy and transport sectors (figure 3.1.13). Only 4 percent ($20.2 billion) was channeled into the WSS subsector; flows into other water subsectors, amounting to less than 1 percent, were either negligible or unavailable in the database.

FIGURE 3.1.13 Breakdown of Infrastructure Investments in Four Sectors, 2017



Source: Authors' elaboration using SPI–PPI database available at World Bank (2019b).
ICT = information and communications technology.

SOEs play a predominant role in the development of infrastructure (figure 3.1.14). Of the $485 billion in infrastructure investments in 2017, almost 55 percent ($265 billion) came from SOEs, and 28 percent ($138 billion) coming from public entities or governments. The share of SOE-led investments was particularly pronounced in EAP (74 percent), ECA (57 percent), and SA (44 percent). It is perhaps important to note that although project-level infrastructure investment by public entities is part of government fiscal budget data, SOE project-level investments, by contrast, occur mainly as off-budget spending. So, the actual share of government infrastructure investment (or capital spending) is likely to be even larger than what is currently estimated.

Curiously, despite their predominant role in infrastructure development generally, SOEs play a much smaller infrastructure development role in the WSS subsector. Almost 80 percent of the total investment value of WSS infrastructure projects in 2017 was in the form of government-funded projects. SOE-funded projects constituted only some 11 percent. That SOEs play a much smaller role in WSS infrastructure development is again reflected in the average value of all documented

SOE-funded projects (figure 3.1.14), which in 2017 was roughly $512 million for all sectors compared with just $104 million for government-funded projects; yet when it comes to WSS projects, the average value of SOE-funded WSS projects in 2017—$38 million—was hardly more than one-third that of government-funded WSS projects ($90 million, figure 3.1.15).

Although there are several potential reasons why the funding role of SOEs in infrastructure development in WSS differs so markedly from their role in other sectors, the findings described above point once again to a recurring theme—that the water sector has unique characteristics that, even within the public sector, predispose governments to play the more dominant role in financing and developing the WSS subsector.

FIGURE 3.1.14 **Total and WSS Infrastructure Investment and Breakdown of Investment by SOEs, Public Entities, and Private Sector, in 2017**

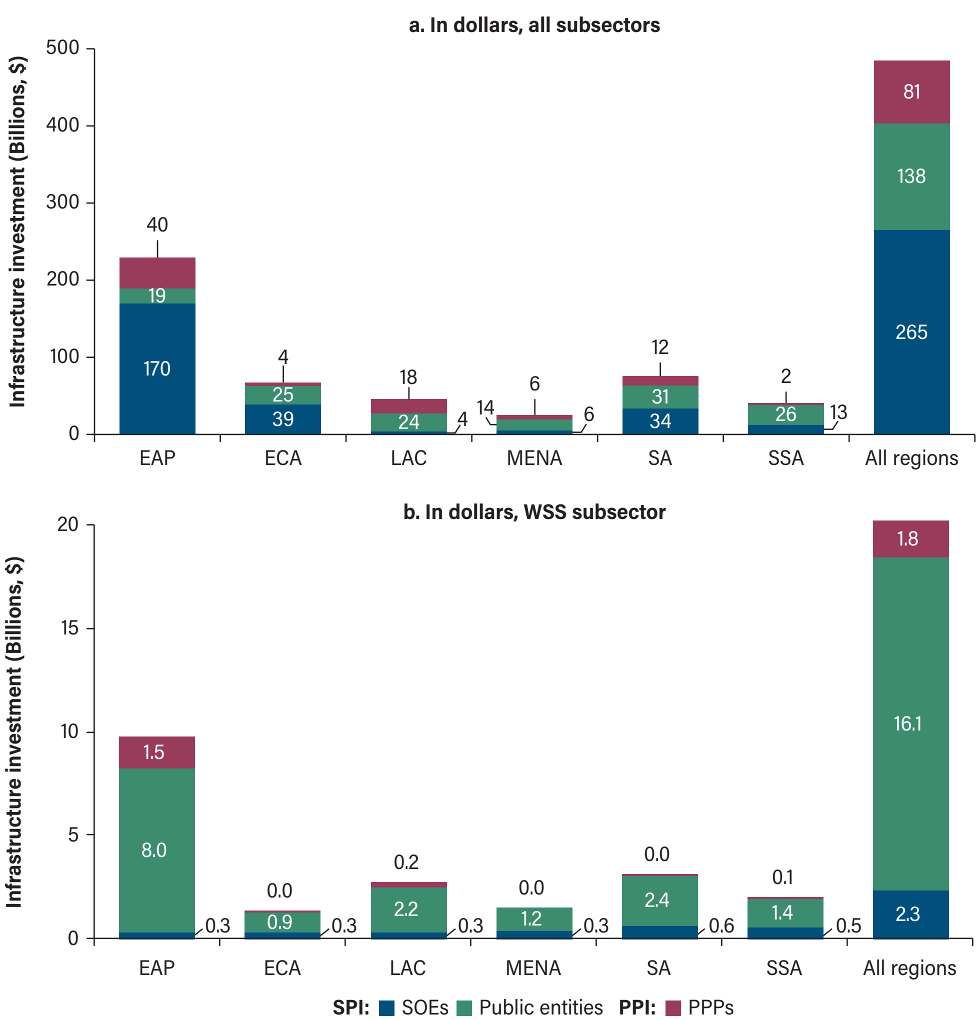


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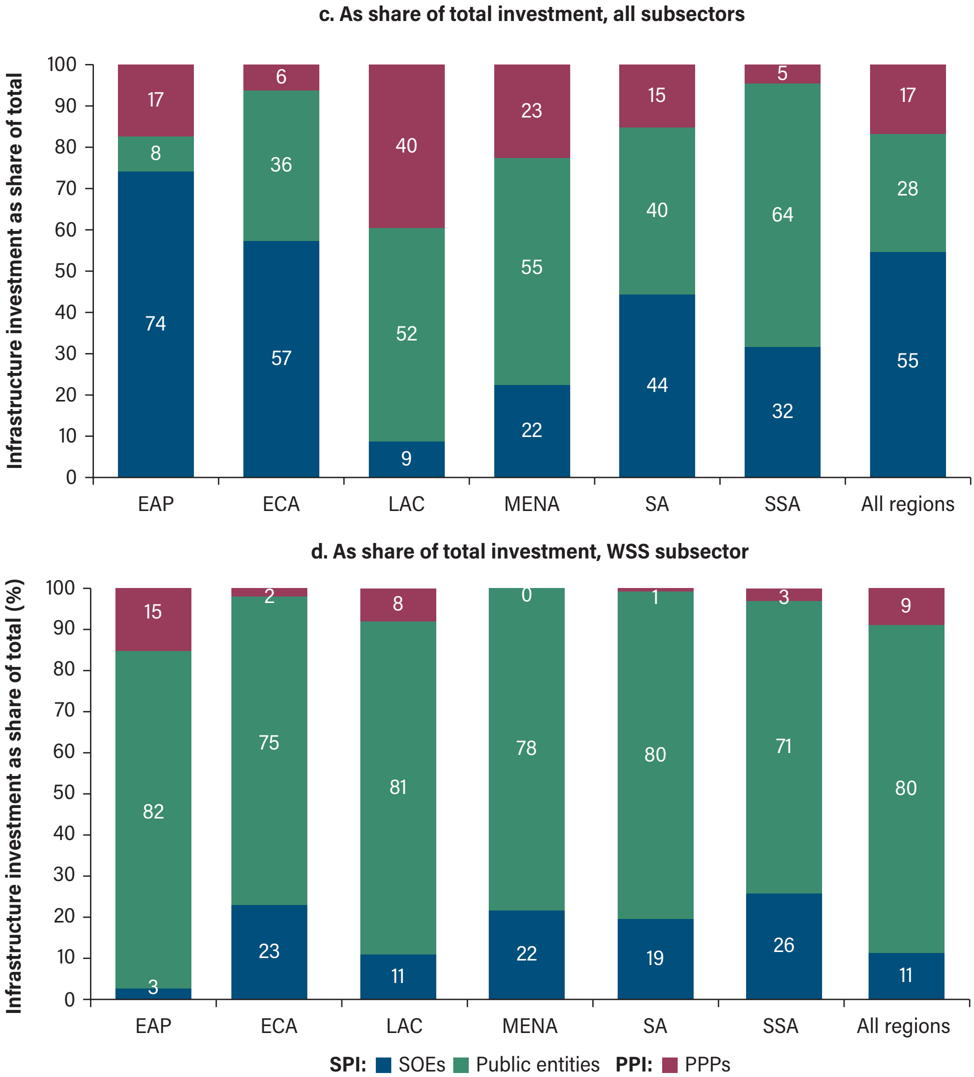
FIGURE 3.1.14 **Total and WSS Infrastructure Investment and Breakdown of Investment by SOEs, Public Entities, and Private Sector, in 2017 (*Continued*)**

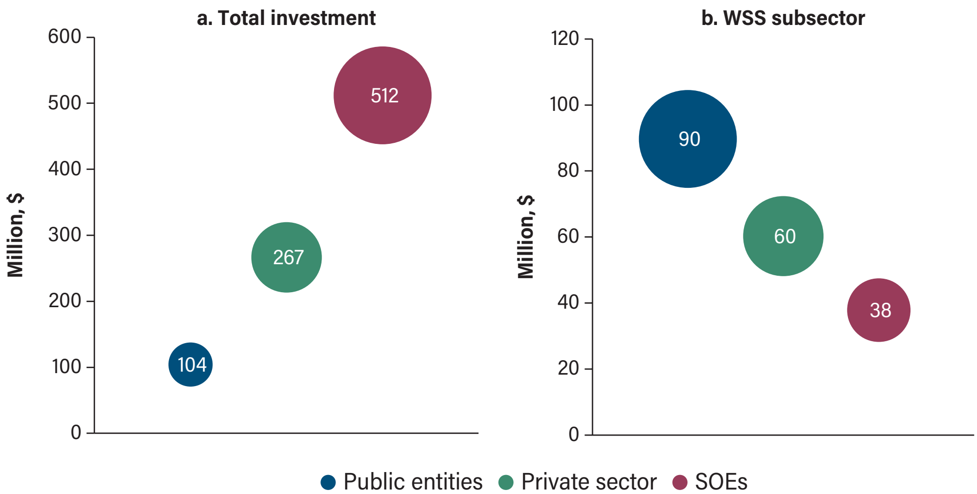


Source: Authors' calculation using SPI–PPI database.

PRIVATE SECTOR INVESTMENTS

Overall, the private sector plays a smaller role in infrastructure development compared to SOEs. In 2017, the private sector made up about 17 percent ($81 billion) of the total investment value of infrastructure projects in all sectors (figure 3.1.14). Private sector participation in WSS infrastructure investments was significantly smaller. In 2017, it constituted only some 9 percent ($1.8 billion) of total WSS infrastructure investment value.

FIGURE 3.1.15 **Average Value of Total Infrastructure and WSS Infrastructure Projects, by Source, 2017**



Source: Overall investment from SPI–PPI report; WSS project values from authors' elaboration using SPI–PPI database.
Note: WSS = water supply and sanitation; SOEs = state-owned enterprises; PPI = private participation in infrastructure.

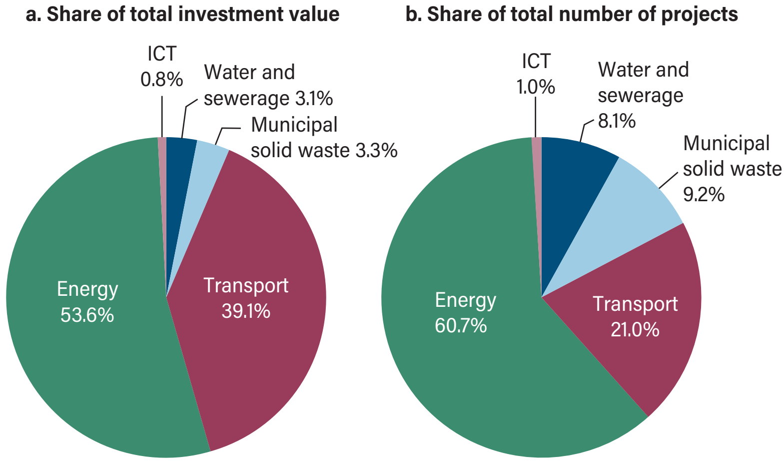
Both in dollar terms and number of projects, private sector-funded infrastructure investments—364 projects, including PPPs, costing about $36 billion—tend to be concentrated in other sectors, especially transport and energy (figure 3.1.16). Between 2009 and 2019, almost 93 percent of total private sector investment value, and 82 percent of all projects, were directed to these two sectors. WSS made up only about 3 percent of total private sector infrastructure investment value and 8 percent of the total number of projects.[13]

After peaking in 2012 in both number of projects and dollar terms—557 individual projects totaling about $151 billion—private sector infrastructure investments declined to a decadal low in 2016 before increasing again (figure 3.1.17). By 2019, those investments had fallen to roughly $97 billion across 406 individual projects. The reduction was driven by a dampened investment climate in certain countries and the cancellation of several projects based on PPP contracts (World Bank 2019a, 2019b, 2020).

By contrast, between 2009 and 2019, private sector infrastructure investments in WSS were relatively more unpredictable (figure 3.1.17). In 2009, total private sector investments in 42 WSS projects slightly exceeded $2.0 billion.[14] By 2011, both the number and dollar figures had almost halved, before rising again by 2012. In 2019 alone, total PPP investments were around $4 billion across 50 projects.

WSS made up only about 3 percent of total private sector infrastructure investment value between 2009 and 2019.

FIGURE 3.1.16 PPI Infrastructure Investments by Sector, 2009–19



Source: World Bank (2022).
Note: PPP = Public–private partnerships; PPI = Private participation in infrastructure; PPI = PPP + exclusively private.

FIGURE 3.1.17 PPI Infrastructure Investments by Total Investment Value and Total Number of Projects, 2009–19

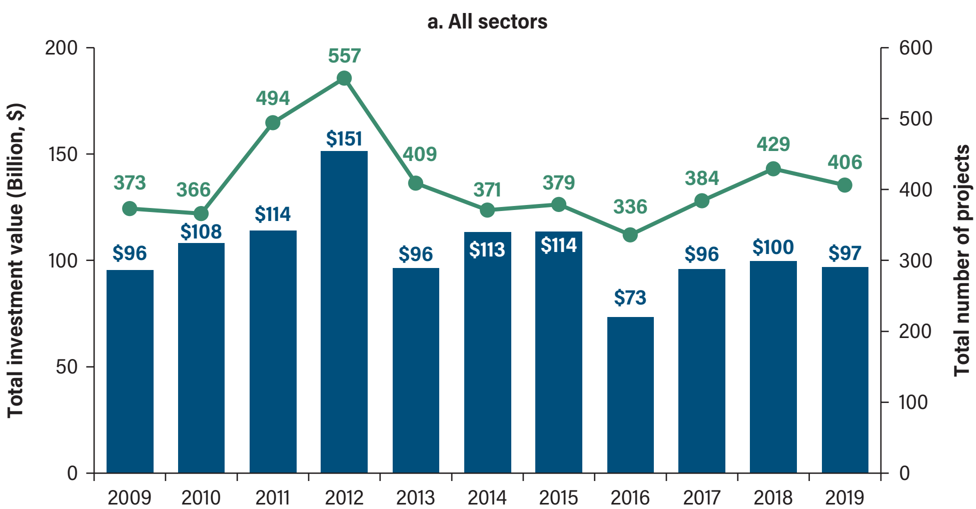


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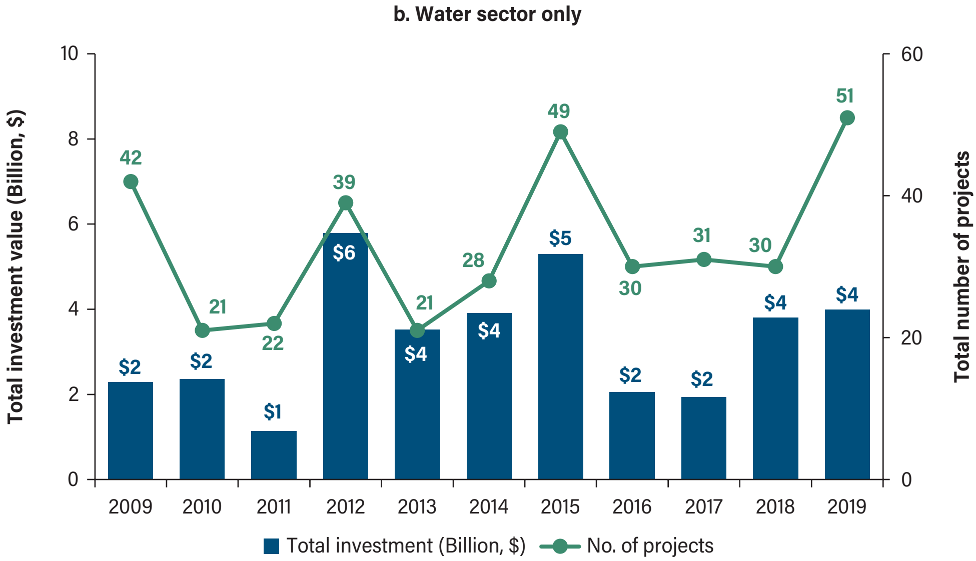
FIGURE 3.1.17 PPI Infrastructure Investments by Total Investment Value and Total Number of Projects, 2009–19 (*Continued*)



Source: Overall investment is from (World Bank (2022); WSS investment and number of projects from World Bank elaboration using PPP database.
Note: WSS = Water supply and sanitation; PPP = Public–private partnerships; PPI = Private participation in infrastructure; PPI = PPP + exclusively private.

The Correlates of Water Sector Public Spending

PER CAPITA GDP GROWTH

Considering the water sector's numerous links to other economic sectors, it should not be surprising that changes in the sector are correlated with changes elsewhere in the economy. For one, spending in the water sector appears to increase with economic growth as measured by GDP per capita. Shown in figure 3.1.18 are the correlations between GDP per capita and per capita public spending in the water sector, WSS subsector, and irrigation subsector.[15] The different colors on the scatter plot depict different income groups for countries.

FIGURE 3.1.18 **Correlations between GDP per Capita and Spending per Capita, per Country Income Group (in 2017 prices)**

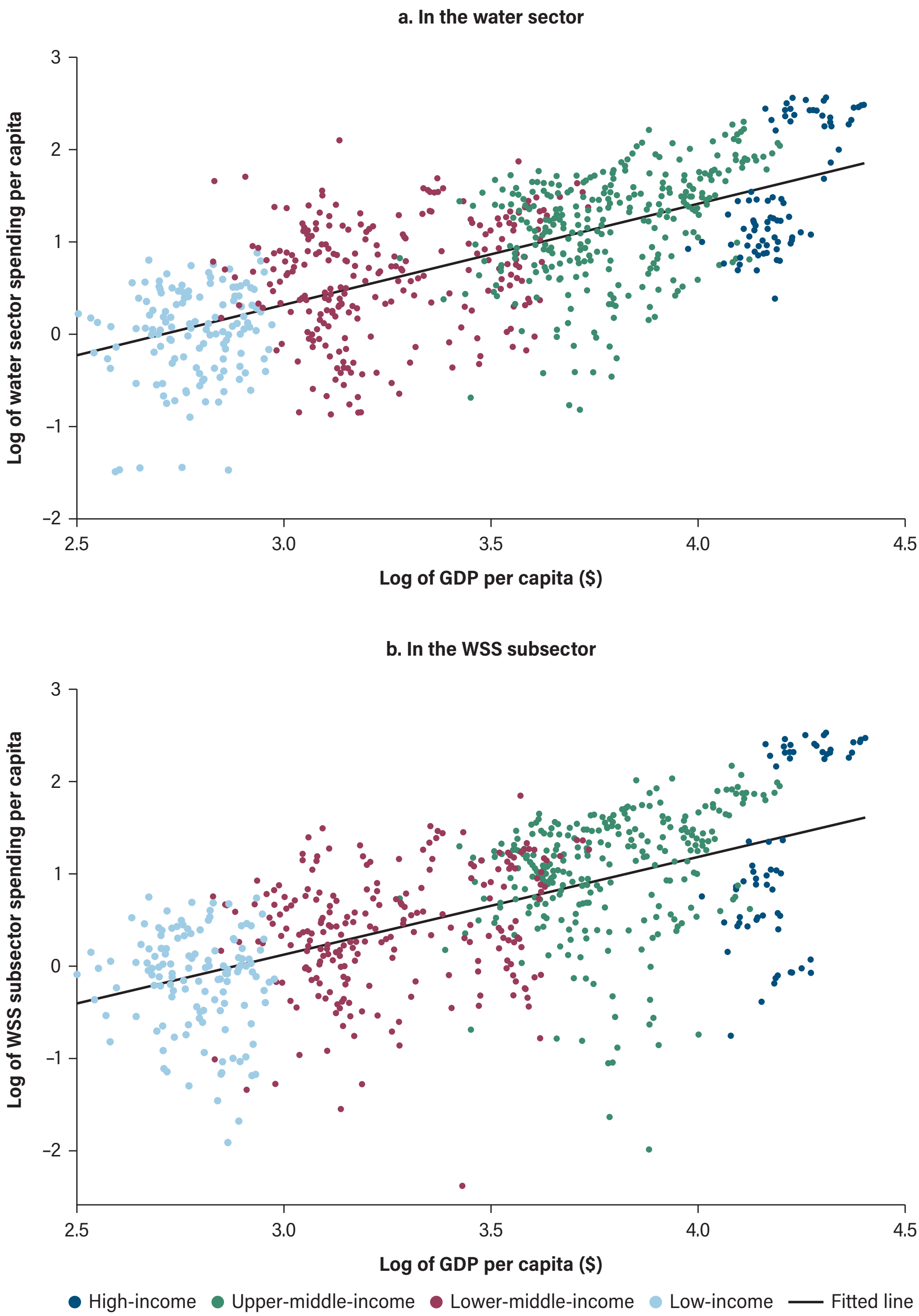


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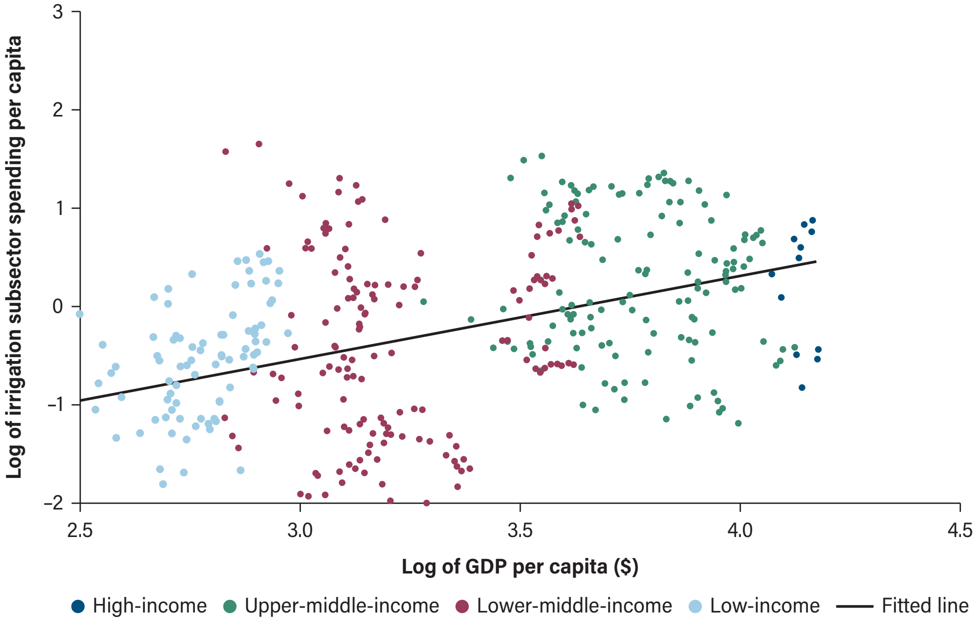
FIGURE 3.1.18 Correlations between GDP per Capita and Spending per Capita, per Country Income Group (in 2017 prices) (*Continued*)

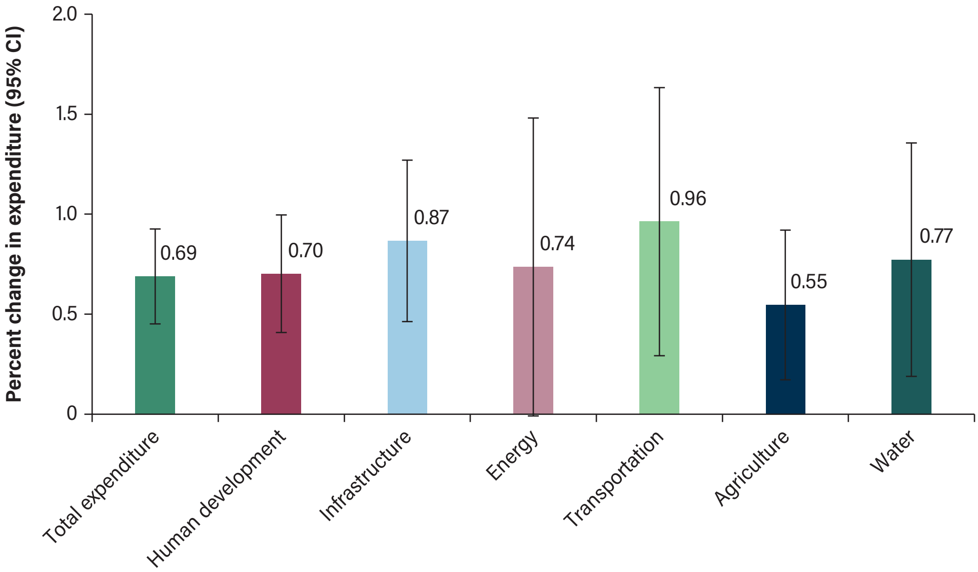
c. In the irrigation subsector



Source: Authors' estimation using BOOST database.
Note: WSS = water supply and sanitation.

This relationship is further examined through a series of panel regressions, specifically via a log-log specification to estimate the elasticity of sectoral expenditures with respect to GDP. This functional form allows for the coefficients to be interpreted directly as elasticities. The model incorporates current and lagged values of GDP, as well as the lagged values of expenditures, to account for potential delayed responses in sectoral budget allocations relative to economic changes. Thus, this section of the study examines how growth in GDP per capita affects public spending, including total expenditure per capita and per capita spending, in eight sectors and subsectors: (i) human development (HD) (that is, social protection, education, and health); (ii) infrastructure; (iii) energy; (iv) transport; (v) agriculture; and (vi) water. The results of the regressions are presented visually in figure 3.1.19, which presents the elasticities of sectoral expenditures in response to income changes. The accompanying 95% confidence intervals reveal the precision of these estimates, with narrower intervals for human development and infrastructure indicating more certainty in the measured responsiveness, whereas wider intervals for energy, transportation, and water suggest greater variability in the relationship between income changes and sectoral expenditure.

FIGURE 3.1.19 Estimated Coefficients from the Panel Regressions Showing Correlation between Change in Public Expenditure and Change in GDP Income (Elasticity Models) Presented in Table 3.1.1



Source: Authors' estimation using BOOST database.
Note: Vertical lines indicate the confidence interval (CI).

The econometric analysis shows a nuanced portrait of sectoral expenditure responsiveness to economic growth. For every one percent augmentation in GDP, aggregate public expenditure is poised to increase by 0.689 percent, a substantial yet less than one-to-one correspondence, which underscores a tempered fiscal approach to scaling sectoral budgets in tandem with economic expansion. In the realm of human development and infrastructure, the elasticity coefficients stand at 0.702 and 0.867 respectively, exceeding that of the aggregate measure. This differential suggests that expenditures in these sectors are particularly attuned to GDP fluctuations. The transport sector, with the highest elasticity of 0.963, signals an a nearly one to one responsiveness to changes in GDP while agricultural expenditure, with an elasticity of 0.546 is the least responsive sector. The water sector's elasticity of 0.773 points to a less than proportionate responsiveness to changes in GDP.

Public spending in the water sector tends to change at a slower rate than changes in GDP, and at a slower rate than it does in the overall infrastructure and transport sectors.

In other words, public spending in the water sector tends to change at a slower rate than changes in GDP, and at a slower rate than it does in the overall infrastructure and transport sectors. A possible reason is that governments and societies tend to perceive upgrades in the transport sector as a more upwardly mobile, prestigious, and visible sign of national progress than less visible upgrades in irrigation (which is rural-focused) or WSS, which benefit those who lack access (the poor).

Discussion and Closing Reflections

This chapter has focused on the patterns of public spending in the water sector. Both the fiscal and project-level data used in this chapter highlight the predominant role of the public sector (governments and SOEs) in water sector spending. Overall, the public sector accounted for almost 91.4 percent of total spending in 2017. Individually, public entities accounted for 85.5 percent of spending in the water sector, with SOEs covering the other 5.9 percent. Similar findings were observed for infrastructure investments in the WSS sector using project-level data from the SPI–PPI database, where government entities accounted for most infrastructure investments.

THE MIXED MANDATE OF SOES

In many developing and emerging economies, SOEs play a significant role in infrastructure investments. Overall, in the Europe and Central Asia, Middle East and North Africa, South Asia, and Sub-Saharan Africa regions, SOEs finance almost 55 percent of all infrastructure investments and at least one-fifth of infrastructure investments in WSS. Governments tend to regard SOEs as policy tools to pursue particular economic, social, and political objectives. This often gives SOEs a mixed mandate that includes social goals of a nonpecuniary nature, such as employment creation, poverty alleviation, environmental protection, and sector regulation (IEG 2020). At their best, they perform this mandate by addressing market failures or providing services at affordable prices. For example, the Kenya Power and Lighting Company, the centerpiece of the Kenyan government's plan to achieve universal electricity access, created more than 1 million new connections each year (IEG 2020). Singapore, after its independence, also successfully used SOEs to drive development and industrialization in multiple economic sectors, including oil refining, shipbuilding, and petrochemicals (IEG 2020). But these success stories are not always the norm.

PPPS—A YET UNFULFILLED PROMISE

For their part, public–private partnerships' share of spending in infrastructure is still limited despite the advantages and options they could offer[16], to bridge the investment gap and provide governments with opportunities to expand their fiscal space. Although the private sector has often brought efficiency and innovation gains to infrastructure development, in 2017 private sector investments in infrastructure made up only about 17 percent of all infrastructure investments, compared to 55 percent for SOEs (World Bank 2019b). PPPs' share in WSS infrastructure investments was even lower, just 9 percent (World Bank 2019b). This finding is consistent with previous reports. For example, Bertomeu-Sanchez and Estache (2019) found that, in most countries, since 1990, large WSS sector utilities have remained under public ownership, even after they have signed at least one PPP contract. In summary, in most countries, in the water sector / WSS are still financed mainly by the public sector, and PPPs are the exception rather than the rule (Bagnoli et al. 2021).

THE WATER SECTOR'S UNIQUE RISK–RETURN PROFILE

The limited role of PPPs can perhaps be explained by the water sector's risk–return profile, which makes it less attractive for private participation. Water sector infrastructure projects require intensive capital investments and significant sunk costs. The physical assets are expected to have a long lifespan, yet water operators are faced with significant depreciation rates, between 3 and 5 percent annually. Water sector projects, partly as a result of low average tariffs, also have long payback periods (15–30 years) with low rates of return (Marques 2018). Other risks include the uncertainty associated with the price of water—that is, the costs of accessing, storing, treating, and supplying bulk water—all of which could also increase with climate change (Catalano, Forni, and Pezzolla 2020; Hutton and Varughese 2016; Lima, Brochado, and Marques 2021). Additional related challenges that, although not unique to the water sector, nevertheless still heighten the risks for private participation include poorly designed contracts, inadequate regulatory institutions to facilitate and safeguard private participation, the poor macroeconomic outlook of many low-income developing countries, and government instability (Lima, Brochado, and Marques 2021). If these challenges were addressed, it could attract greater private participation into the sector.

THE POTENTIAL ROLE OF PPPS IN TECHNOLOGY ADVANCEMENT AND THE CIRCULAR ECONOMY

An intriguing possibility for attracting greater PPP engagement with the water sector is through the innovative value-creation opportunities offered by the circular-economy possibilities of water services. The water sector has abundant circular-economy potential that requires a significant level of innovation and technology to tap into. The private sector has often driven innovation in the water sector and brought technical expertise to it. An example is Singapore's NEWater reclamation plants, which use advanced membrane microfiltration, reverse osmosis, and ultraviolet irradiation disinfection technologies to treat wastewater and produce ultra-clean, high-quality, reclaimed water that meets World Health Organization (WHO) standards for safe drinking water (Bai et al. 2020; World Bank 2018). Two of the four NEWater plants were developed using a PPP model and private financing through Design-Build-Own-Operate (DBOO) concession contracts (World Bank 2018). This means the private consortia that were awarded the contracts assume the risk of designing, building, owning, and operating the plants (World Bank 2018), in exchange for higher investment returns than might have been the case. Currently, NEWater supplies up to 30 percent of Singapore's clean water (World Bank 2018), with plans to raise that to 50 percent by 2060.

Beyond the reuse and recycling of wastewater for drinking, other byproducts from water services also have significant circular-economy potential. For example, the WSS subsector is a global source of methane emissions (Giné-Garriga et al. 2023). Methane can be captured from wastewater and transformed into renewable biofuel or renewable natural gas (RNG) and resold for energy generation (Torres-Sebastián et al. 2021; Wang et al. 2021).[17]

Methane can also be converted into hydrogen in a process that is considered to have significant economic potential (Kane and Gil 2022; Sánchez-Bastardo, Schlögl, and Ruland 2021).[18] In fact, the demand for hydrogen is expected to surge to 500–680 million metric tons (MT) by 2050, from 87 million MT in 2020 (IEA 2019). Through a *value-capture* approach, potential water sector PPP projects could be paired with an "energy component" to draw private investments into the water sector.[19] Like hydropower, which attracts significant numbers of PPPs, this is another example of the potentially synergistic nexus between water sector and energy sector infrastructure projects.

POTENTIAL CHALLENGES SOES AND PPPS FACE AS WATER SECTOR FUNDING SOURCES

Despite the potentially promising lines of opportunity discussed above, SOEs and PPPs both have their demerits as modes of public service provision. For one, the mixed mandate of SOEs, often accompanied by soft budget constraints, lax regulatory oversight, and political interference that can undermine their autonomy, can raise the risk that they will underperform. Such underperformance, if it is not handled skillfully, may lead to substantial financial distress, which can not only affect national fiscal discipline but undermine both consumers' access to, and the quality of, services (Melecky 2021) (box 3.1.2). For similar reasons, privatizing a water utility does not always lead to commercial success. Although studies demonstrate that it can result in higher water quality and compliance with water safety standards, there is no broad consensus that privatization improves operational efficiency, coverage of services, or service pricing (Fabre and Straub 2021) (box 3.1.3).

Overall, there is little evidence to suggest that, in the attempt to achieve desirable commercial, and economic outcomes, the type of ownership structure of the service provider consistently makes a difference—or consistently makes the same *kind* of difference every time. Although public institutions are more likely to address social needs, many living in poverty in the developing world continue to lack access to essential services, even where the primary providers are public (Bagnoli et al. 2021). Instead, growing evidence firmly suggests that institutional and regulatory weaknesses make a marked difference to a country's ability to meet social goals, regardless of service provider type (Bagnoli et al. 2021). Studies show that a sound regulatory framework, properly enforced, can positively impact firm performance regardless of ownership arrangement (Imam, Jamasb, and Llorca 2019; Vagliasindi 2012). However, this is not to say that ownership arrangements

BOX 3.1.2 Soft Budget Constraints: How Underperforming SOEs Financially Burden Governments

The mixed mandates of SOEs often create a conflict of interests that dilutes the organization's focus and diminishes its incentives for performance, in the process creating a range of governance and performance challenges. Acting as proxies for the government, SOEs, for example, may represent the state's political will to influence economic outcomes and resource allocation in a certain way, and may therefore be required to carry out socially-driven mandates that are financially unsustainable (IEG 2020). As a result, profit maximization may not necessarily be their primary (or even secondary) operational goal. While it is possible to find SOEs that are run well, many others suffer from low productivity and inefficiency and persistently make losses (Melecky 2021). **Second, the mixed mandates make oversight difficult**, resulting in principal–agent challenges such as moral hazard in the form of opportunistic behavior causing financial losses to the SOEs. As mentioned, as a governmental instrument to influence economic outcomes, SOEs may face political interference, undermining their autonomy and complicating the independence of oversight and regulatory functions. As a result, SOEs often lack adequate governance arrangements and transparency, which can encourage mismanagement, corruption, further underperformance, and poor service (Burdescu et al. 2020; IEG 2020). Eventually, underperforming SOEs may incur losses that become patently unsustainable, culminating in the necessity of a costly government bailout (Melecky 2021).

Third, governments often apply "soft budget constraints" to SOEs in the form of access to softer loans with lower interest rates and looser conditions. Indeed, evidence suggests that governments are prone to covering SOE losses simply by overlaying additional loans like a Band-Aid (Melecky 2021), a telltale sign of which is their frequently high debt ratios. Such easy terms and soft treatment, combined with loose oversight and regulation, tends to encourage moral hazard—the exercise of less care by economic actors that have reason to believe they will not bear full responsibility. The result is that, like the influence of an enabling parent on an undisciplined child, underperforming SOEs have little incentive to perform well. Although soft budget constraints are not necessarily the only driver of poor financial performance, they have likely played a large role in the growth of contingent SOE liabilities in many economies.

For example, India's federally-owned SOEs, or central public sector enterprises (CPSEs), are 15–21 percentage points more likely to experience financial distress than their private sector peers (Melecky 2021). The fiscal burden on an economy imposed by distressed SOEs can be overwhelmingly debilitating. A startling example is that it has been estimated that in recent years in Pakistan, the total liabilities of chronic SOE loss-makers amount to about 8–12 percent of GDP (Melecky 2021). In Sri Lanka, the liabilities of loss-making SOEs have hovered around 4–5 percent of GDP (Melecky 2021).

Whether SOEs present as impediments to economic growth or as contributors to long-term policy goals can be debated, but the benchmarks used to measure their performance indicate that they do indeed tend to underperform (Vagliasindi, Cordella and Clifton 2021). Nonetheless, successful SOEs have been pivotal in achieving specific economic goals. Studies also suggest that, in some cases, SOEs are more likely than large private service providers to meet the needs of vulnerable households (albeit often at the cost of considerable inefficiency) (Bagnoli et al. 2021). In other words, some SOEs do what others are not willing to do. Thus, measuring their performance using standards designed for profit-maximizing private firms may be missing the point. Instead, it may be more appropriate to assess whether SOEs under- or over-perform private firms for the objectives for which they were created, and at what cost (Vagliasindi, Cordella and Clifton 2021). On the flip side, governments need to play an active role in creating regulatory frameworks to oversee SOEs with appropriate checks and balances. The enforcement of such frameworks might help to prevent dire levels of underperformance that, if left unchecked, could put SOEs and the economies in which they operate, in financial distress. Along the same lines, to avoid moral hazard behavior among SOEs, governments need to openly acknowledge and confront the reality of inefficiency-enabling soft-budget constraints.

BOX 3.1.3 Do Water Sector Public–Private Partnerships Work? The Evidence for and against Their Performance

There is no firm consensus in the literature about the efficiency gains of private water utilities in developing countries. The results have mostly been mixed. Labor productivity, such as connections per worker and water sold per worker, tends to be higher among private water utilities, which may, at least in part, be driven by reductions in the workforce. This trend is observed among private water utilities in parts of LAC, Central Asia, and EAP (Gassner, Popov, and Pushak 2008). The same cannot be said for private water utilities in China. One study found that while private water utilities there yield significant cost savings through workforce downsizing and reductions in managerial expenses, the cost savings do not improve labor productivity (Jiang and Zheng 2015). Econometric studies employing stochastic frontier analyses (SFA) have reached similar conclusions about privately owned utilities in Africa and EAP (Estache, GonzÁlez, and Trujillo 2002; Kirkpatrick, Parker, and Zhang 2006).

By contrast, in Latin America, it was found that the transition to private utilities is associated with a significant decrease in non-revenue water (NRW), which is a good proxy for efficiency improvement (Andrés, Schwartz, and Guasch 2013; Estache, Gonzalez, and Trujillo 2002; Jiang and Zheng 2015; Kirkpatrick, Parker, and Zhang 2006).

The transition to privately managed water utilities may also lead to improved water quality. A study in France covering 2,200 French municipalities between 1998 and 2008 found that private water utilities are more compliant with the microbiological requirements set by regulatory bodies (Porcher et al. 2012). The same has been found with the high compliance levels with which private water utilities in the United States respond to the Safe Drinking Water Act (Lyon, Wren Montgomery, and Zhao 2017).

The evidence that privatizing water utilities may lead to improved water quality also extends to developing countries. For example, the privatization of the Buenos Aires water system in Argentina led to a significant improvement in water quality and subsequently improved child mortality (Galiani, Gertler, and Schargrodsky 2005).

There is, however, limited evidence in developing countries that the privatization of water utilities leads to increased coverage. On the plus side, increased coverage of households was linked to privatization efforts in Bolivia and Argentina (Galiani, Gertler, and Schargrodsky 2005; McKenzie et al. 2003). In Argentina, accompanying the increase in coverage was an improvement in service quality as well. Through a difference-in-difference analysis, it was found that the privatizations led to lower levels of child mortality associated with waterborne diseases. These privatization efforts, however, were more likely to occur in larger and less well-off municipalities and those with a local government that supported the federal government's agenda pushing for increased privatization (Galiani, Gertler, and Schargrodsky 2005). Still, most of the increases in coverage can be accounted for by increasing trends over time.

The results are also mixed when it comes to affordability. Privatization led to a decrease in prices in Bolivia, but not in other developing countries (McKenzie et al. 2003). A rise in productivity or a reduction in costs does not necessarily translate easily into cheaper water because the transition to private water utilities has often occurred in the context of prices that were already set well-below cost recovery levels. Thus, many potential factors are intertwined and endogenous to the privatization of water utilities and their subsequent performance.

The study in France mentioned earlier highlights this perfectly. At the same time, the privatization of water utilities in France was associated with higher-than-average prices compared to public water utilities, but the difference dissipates once the technical characteristics of the water supply conditions, and the contractual characteristics of water concessions, are controlled for (Porcher and Saussier 2018). The only exception is for smaller municipalities where the average price of water under private provision is higher than that of public provision. Higher water prices were not observed in larger cities in France because they could challenge private incumbents by attracting competitive bids or by providing the service themselves.

are irrelevant or that they have no effect on outcomes. Indeed, in the context of a given political economy and country profile or a given subsector, one approach may be better than the other.

LOW CAPITAL AND MAINTENANCE SPENDING AMID ADVERSE CLIMATE CHANGE

Beyond the role of SOEs and PPPs, several other findings from our examination of public spending in the water sector merit attention. **One is the potential effects of low maintenance spending, especially in the WSS, irrigation, and water transport subsectors.** As discussed earlier in this chapter, periodic systematic maintenance protects the physical condition and functioning of infrastructure and can markedly reduce the lifecycle costs of water infrastructure (Rozenberg and Fay 2019).

The culture of low maintenance in the water sectors of many countries is distressing for another reason. Many governments will need to adapt their water sector infrastructure to climate change[20] because it can impact infrastructure in multiples ways, making it all the more pressing to follow a maintenance protocol that keeps such infrastructure in optimal shape so that it is resilient against climate-induced stresses. Heavy precipitation can cause soil erosion or runoffs, damaging infrastructure. At the other extreme, drought accompanied by high temperatures can accelerate pipe and sewer line corrosion. Taken together, these risks can exact high costs on poorly maintained infrastructure. In addition, increased variability in the severity, duration, and frequency of climate change-induced events, and changes in the water cycle, will likely raise the cost of both adaptation and maintenance.

THE MOBILIZING POWER OF VISION, EMOTION, AND LEADERSHIP

In 2014, Prime Minister Narendra Modi launched a country-wide "People's Movement" to completely eliminate open defecation in India. Called the **Clean India Mission**, it resulted in the construction of an estimated 100 million toilets in India, and counting.

More than three million students, government employees, and citizens, motivated by the vision and emotion of achieving an "open defecation-free" India by October 2, 2019—*Mahatma Gandhi's 150th birthday anniversary*—plied the length and breadth of the country building toilets for free. In 2014, fewer than 40 percent of rural households owned a toilet. Today, estimates say between 75 percent and 100 percent do.

Using social and behavioral change tools, the **Swachh Bharat Mission**—its official name in Hindi—is to date the world's largest sanitation and behavioral change initiative. Because of it, India achieved SDG target 6.2 *eleven years ahead of time*.

Soon after the first phase had ended, the government launched Phase 2. Then in 2019, capitalizing on the momentum, it initiated the **Jal Jeevan Mission**, a project to provide all of rural India with drinking-quality tap water connections. The WHO reports that the number of rural Indian households with tap water connections rose from 16.64 percent in 2019 to **more than 63 percent** within just 41 months.[1]

Together, these two projects are a testament to the power of government leadership to mobilize resources – financial and human -nationwide to achieve important goals in the water sector.

[1] DC Correspondent, "Jal Jeevan Mission gives term health and socio-economic outcomes," *Deccan Chronicle,* June 27, 2023, https://www.deccanchronicle.com/nation/in-other-news/270623/jal-jeevan-mission-gives-term-health-and-socio-economic-outcomes.html

HOW BROAD-BASED NATIONAL SUPPORT CAN OVERCOME THE PARALYSIS OF PATH DEPENDENCY

Historically, public spending levels have been lower in the water sector than in other infrastructure sectors such as energy and transport. As shown earlier, between 2009 and 2020, with few minor deviations, it constituted only 1.2 percent of total public spending on average. This can perhaps be explained, at least in part, by the path dependency of the spending levels that were set by governments long ago in the past. Path dependency creates inertia, and inertia undermines the agility of communities, organizations, ministries, and governments to respond to current realities and new developments. What this sometimes means is that unless or until there is a country-level shift in the national political agenda toward revitalizing a country's water sector—two recent examples of this are India's Clean India Campaign of 2014 and its Jal Jeevan Mission of 2019 (see side box)—spending levels in the sector may not see significant change, despite appeals to do something about the issue.

This is why, historically, spending on infrastructure has, for better or worse been influenced—in some cases even determined—by political agendas and national plans. An example of this is the development of the Interstate Highway System in the 1950s in the United States. Launched amid growing widespread pressure on the government to construct a safe, efficient transcontinental highway network, the share of federal spending on transport almost doubled—from 2.7 percent in 1956, when the Federal-Aid Highway Act was passed, to above 5 percent by the 1960s.[21] The result was a state-of-the-art interstate system that, for a number of years at least, became the envy of the world.

Similarly, as happened with the US interstate system, public spending on water sectors of various countries may increase if some combination of civil society, media outlets, and that country's international partners are able to find a way to place it front and center on the national agenda. Without that, it is uncertain how or when change might come. Nevertheless, with the risks of climate change rising by the season, more and more countries may well find that they have little choice but to begin to incorporate the water sector into their national plans.

METHODOLOGICAL CAVEATS AND LIMITATIONS

There are several limitations to the BOOST database used for the public spending analysis presented in this chapter. It excludes data on government off-budget spending and investments by SOEs, except for capital transfers from the national budget. In our analyses, we therefore obtained estimates of spending by PPPs and SOEs from the SPI–PPI databases. The exclusion of SOE data is significant because SOEs are a substantial share of the WSS, electricity, and transport sectors.

Another concern about this database is the frequent occurrence of missing values, especially in the earlier years and in particular sectors (such as irrigation and hydropower). The lack of data for certain subsectors also relates to the inconsistencies of budget classifications that do not clearly identify sectoral spending.

Yet another concern is that the countries included in the BOOST database are not representative of all regions and income groups. For example, BOOST under-represents countries in the EAP, MENA, and SA regions. Furthermore, some upper-middle-income countries are not in the BOOST database because of the World Bank's selective engagement. This can lead to selection bias, which means that the results obtained from the database may not be sufficiently representative and may therefore not be generalizable to the excluded countries or regions.

Notes

1. Countries with less than 5 years of information provided were excluded. The subset of BOOST countries used in this chapter for computing spending estimations differs from those used in part 2 chapter 1 for modeling spending estimations. For more on the methodology and the list of countries included in both sets of analysis, refer to table appendix 2.1.a table 1.
2. The World Bank's SPI–PPI database combines investment information from the Bank's existing PPI database and a relatively new data set of state-owned enterprise and public sector-funded projects, the SPI data set. It was developed in 2017 with support from Public-Private Infrastructure Advisory Facility (PPIAF). A project is considered a PPI project if its majority investment partners are from the private sector, and considered an SPI project if the majority investors are SOEs or public entity. See World Bank (2019b). The SPI–PPI database, besides reporting information on commitments rather than actual investments, uses project-level data available from various outlets, including news media, and hence has limitations to its accuracy and comprehensiveness. Also, nearly all the water sector spending data available in the SPI and PPI databases are limited to the WSS subsector.
3. In 2017, it is estimated that nearly 80.0 percent of water sector ODA was channeled to the public sector, including central and local government recipients. It is uncertain to what extent these funds are reflected in the government budget recorded by the BOOST database. There is a possibility for double counting to some extent here.
4. Information on the irrigation and hydropower subsectors is available for fewer countries.
5. Across all the countries where data were available including high-income countries, water sector spending declined from an average of about 1.3 percent of total public spending in 2010 to about 1.1 percent by 2020. This is largely driven by some countries in the sample (N=7), where water sector spending fell by almost half, from close to 3.0 percent to about 1.7 percent of total public spending, on
6. Curiously, there was a slight increase in total public spending in the water transport subsector during the latter half of this period.
7. See World Bank (2017).
8. The OECD Development Assistance Committee (DAC) has 32 members, as of July 4, 2023—31 countries and the EU: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, the European Union, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, the Republic of Korea, Lithuania, Luxembourg, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
9. The reason OOF is included in ODA in this study is that OOF tends to include official bilateral transactions intended to promote development, such as technical assistance and capacity building, that help support development efforts.
10. In the context of Official Development Assistance (ODA) and Other Official Flows (OOF), "representational purpose" generally refers to expenses that are not directly related to development aid, but rather to the costs associated with maintaining diplomatic or official presence in a given country or international setting.

11. This latter category includes, by definition, export credits extended directly to an aid recipient by an official agency or institution (official direct export credits); the net acquisition by governments and central monetary institutions of securities issued by multilateral development banks at market terms; subsidies (grants) to the private sector to soften its credits to developing countries; and funds in support of private investment.
12. For more on this breakdown and analysis, please refer to World Bank (2019b).
13. By extension, using the 2017 estimations, infrastructure investments by PPIs would constitute only 0.52 percent of all infrastructure investments.
14. For more on the PPI investments in the WSS sector, please refer to Deblina (2017).
15. Both variables on the X and Y axes take on the logged form.
16. Governments are able to leverage the resources and expertise of the private sector through risk-sharing arrangements under a PPP. When properly designed and executed, PPPs can create social value through on-time and on-cost delivery, generating efficiency gains and offering innovation in project design, incorporation of global expertise, and accessing new sources of capital.
17. Several wastewater treatment plants in the United States have installed methane-capturing technologies to produce RNGs for other energy purposes. They include the Jose-Santa Clara Regional Wastewater Facility and the Santa Cruz Wastewater Treatment Facility in California, the Sioux City Wastewater Treatment Plant in Iowa, and the Columbia Boulevard Wastewater Treatment Plant in Portland, Oregon. In Portland, the RNG produced from methane capturing help power the city's natural gas vehicles.
18. Efforts are also under way, jointly by Mitsubishi and Monolith, to develop a commercial scale methane pyrolysis facility to produce carbon-zero or carbon-negative hydrogen from methane.
19. Value-capture strategies, usually applied in transport infrastructure projects, refer to mechanisms that allow for the recovery of some of or all the value that public infrastructure generates for private landowners. The increased land value can help finance infrastructure projects (Glaeser and Poterba 2021). In theory, the potential revenue generated from reselling the renewable fuels extracted from wastewater can also help finance the construction of new sewage networks and wastewater treatment plants.
20. Several studies have attempted to estimate adaptation costs to climate change, at various levels and in various contexts (Chapagain et al. 2020; Hughes, Chinowsky, and Strzepek 2010; Ward et al. 2010). Of note, the costs of adaptation to climate change for water infrastructure in OECD countries is estimated to be roughly 1–2 percent of baseline costs, with the primary component of the extra cost being the water resources to meet a higher level of municipal water demand (Hughes, Chinowsky, and Strzepek 2010). Additionally, investments in infrastructure to adapt to climate change as a preventive measure can contribute to higher GDP growth rates compared to remedial measures such as post-disaster relief and construction (Catalano, Forni, and Pezzolla 2020).
21. A summary of federal spending on transport (and water infrastructure) in the United States from 1956 to 2017 can be found in *Public Spending on Transportation and Water Infrastructure, 1956 to 2017* (Congressional Budget Office 2018). In the analyses, federal spending on transport and on water is combined. Nevertheless, it is also observed that, between 1956 and the mid-1960s, spending on water largely remained the same or declined. The increase during the period was therefore driven mainly by federal spending on highways.

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CHAPTER 3.2

Underfunded or Underused?

KEY MESSAGES

- Budget execution rates are low in nearly all water subsectors, including water supply and sanitation (WSS) and irrigation. Despite their limited resources, they fail to fully use the funds allocated to them at the start of the budget year. This paradox highlights the need for better financial management to enhance execution rates in the sector.
- During 2009–20, the sector's budget execution rate averaged 72 percent, with high variation across countries. In other words, more than one-fourth of the funds made available to the sector were not used.

Execution ratio is the ratio of executed expenditure to the allocated budget. An execution budget rate of less than 100 percent results in a spending shortfall and may point to problems in the budget execution process. These in turn may reflect low absorption capacity or governance issues such as lack of transparency, overcaution in spending, poor accountability, financial irregularities, or slow or inaccurate feedback about the execution of the budget.

- The water sector's 72 percent execution rate falls markedly below that of the human development (HD) sector (consistently around 99 percent, with low variation), the transport sector (91 percent), and the agriculture sector (89 percent).
- Low budget execution rates typically indicate low absorptive capacity and relatively poor performance of public financial management systems; but in infrastructure sectors such as water, where capital spending far exceeds salaries and wage bills, spending depends on the speed at which investment projects are implemented.
- There is no clear correlation between budget execution rate and a country's income level, regardless of whether the sector is water, WSS, infrastructure, or HD. Raising execution rates may depend instead on addressing governance issues, such as government effectiveness and state legitimacy, and on improving the quality of political institutions.
- Improving budget execution rates in the WSS subsector could reduce the spending gaps to achieve Sustainable Development Goals (SDG) targets 6.1 and 6.2, as estimated in part 2 chapter 2. For example, if countries reduced the gap in their average budget execution rate by 50 percent—corresponding to a 14 percentage point improvement in the budget execution rate, from 73 to 87 percent—this might reduce the annual spending gap from $141 billion to $128 billion, a $13 billion reduction.

Introduction: Why Does Budget Execution Matter?

In most low- and middle-income countries (LICs and MICs), the water sector is significantly under-resourced compared to the goals set by governments and the international community—specifically, the SDG targets. Yet nearly every water subsector, including WSS and irrigation, fails to fully utilize the funds allocated at the start of the budget year, leading to a budget execution rate well below 100 percent.

The budget execution rate—essentially, the proportion of the budget that is spent—is the ratio of executed spending divided by the approved spending over a given period, usually a fiscal year. For example, an execution rate of 85 percent means that only 85 percent of the original allocated budget was used—leaving 15 percent of the allocated budget unused. An execution rate of over 100 percent means spending was higher than the intended allocated budget (a spending excess).[1] Understanding how well countries have been able to spend their allocated water sector budgets compared to other sectors is important because a steady improvement in the budget execution rate, with minimal deviation from the approved budget allocation, would truly help bridge the spending gaps to attaining the sector's development goals in a planned, systematic manner (box 3.2.1).

Nearly every water subsector, including WSS and irrigation, fails to fully utilize the funds allocated at the start of the budget year.

This chapter examines budget execution in the water sector and subsectors, based on an analysis of public expenditure data from 65 countries[2] from 2019 to 2020, using the BOOST database. First, the analysis compares sectoral execution rates in the infrastructure, water, and HD sectors. This allows us to compare time trends and identify country-to-country differences. The impact of

BOX 3.2.1 Reducing the WSS Spending Gaps by Improving Budget Execution

As discussed in part 2 chapter 2, there are several ways to reduce the spending gap in WSS. These include the 3Ts—budgetary transfers, higher taxes, and higher tariffs—encouraging private investment, and attracting more official development assistance (ODA). But improving budget execution rates—the subject of this chapter—is another major way to narrow the WSS spending gap and is an option that merits more attention.

One obvious argument for improving budget execution is that these funds have already been allocated—just not fully used for reasons ranging from poor governance to project delays.

As shown in table B3.2.1.1 below, reducing the budget execution gap by 50 percent by improving budget execution in the WSS subsector would raise the global rate from an average of 73 percent to 87 percent, a 14-percentage point increase in budget utilization. This would translate into a significant reduction in the global annual spending gap in WSS (to achieve SDG 6.1 and 6.2) from roughly $141 billion to $128 billion—a $13 billion reduction in the WSS spending gap.

Although the overall reduction is significant by any measure, it does need to be noted that most of that gain would be driven by the EAP region. An improvement in budget execution of 50 percent would erase the annual WSS spending shortfall in this region, currently around $2.9 billion, turning it into a $13 billion spending surplus.

box continues next page

BOX 3.2.1 Reducing the WSS Spending Gaps by Improving Budget Execution (*Continued*)

TABLE B3.2.1.1 Reducing WSS Spending Gaps by Improving Budget Execution Rates

Regions	Decadal mean WSS budget execution rate	Estimated current spending	Current annual spending gap	25 percent reduction in execution gap (0.25*(100%-(A)))		50 percent reduction in execution gap (0.50*(100% -(A)))	
				Adjusted budget execution rate	Adjusted spending gap	Adjusted budget execution rate	Adjusted spending gap
	(A) (%)	(B) (Billion, $)	(C) (Billion, $)	(D) (%)	(E) (Billion, $)	(F) (%)	(G) (Billion, $)
SA	81	$4.66	–$36.11	86	–$35.84	91	–$35.56
EAP	56	$40.21	–$2.87	67	$5.02	78	$12.92
MENA	67	$3.14	–$12.11	75	–$11.72	84	–$11.33
SSA	72	$4.59	–$73.48	79	–$73.03	86	–$72.59
ECA	87	$5.62	–$3.18	90	–$2.97	94	–$2.76
LAC	80	$11.31	–$13.06	85	–$12.35	90	–$11.64
All countries	73	$69.53	–$140.80	80	–$134.37	87	–$127.94

*billion, $

Source: Authors' estimation using BOOST and global modeled datasets

Note: WSS = Water supply and sanitation; EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa.

COVID-19 on budget execution is then examined, comparing data from 2019 to 2020 for a smaller subset of countries where data were available. Finally, to better understand the political economy context of the budget execution process, we look at the correlates of budget execution rates, focusing on GDP, governance, regulation, legitimacy, and institutions.

The results show that, over the years, many countries have exhibited significant discrepancies between their approved and executed budgets, with wide country-to-country variation as well as within-country variation over time. Countries with an execution rate of over 100 percent—perhaps because of *ad hoc* policy changes or various external shocks—might simply require supplemental budgets within that fiscal year, but an execution rate persistently lower than 100 percent could be a sign of weakness in fiscal or budgetary planning and implementation, governance inadequacies, or weak sectoral absorptive capacity.

The reasons for weak financial absorptive capacity vary. Typically, infrastructure projects take a long time to complete: on average, 6–15 years in total, of which 3–8 are for preparation and 3–7 years for implementation (IMF 2020). Complications in budget preparation, and delays in the transfer of resources to the line ministries and implementing agencies, can reduce the time available for planning and implementing the project, which will tend to weaken financial absorption. Additionally, even donor-driven projects, that are planned by professional experts and subject to rigorous procedures often experience significant delays that goes beyond their projected completion date at project outset (Briggs 2020; Limodio 2021).

In infrastructure sectors like water, where capital spending far exceeds salaries and wage bills, spending depends on the speed with which project implementation occurs. Weak human resource capacity in preparing and implementing large complex projects, which typically require a range of national and local-level managerial capacities and skills at different stages of the delivery chain, can slow the pace of implementation. That, in turn, will constrain absorptive capacity.

Finally, other factors such as the source of funds, high transaction costs caused by fragmented donor activity, the slow pace of fiscal decentralization, or an inappropriate mix of recurrent and capital funding can also significantly affect absorptive capacity (World Bank 2012). Taken together, the many challenges in the implementation of infrastructure projects such as those in the water sector can impact the sector's absorptive capacity and subsequently its budget execution rates.

Comparing Budget Execution in the Water Sector with Other Sectors

Although budget deviations suggest issues with the effectiveness, efficiency, or adequacy of budget implementation, it is important to note that the budget execution rate indicates merely the (quantitative) extent to which the budget was implemented. It does not necessarily reflect the quality of that implementation or the reasons underlying a particular deviation.

As shown in figure 3.2.1, between 2009 and 2020, the average execution rate in the water sector in the 65 countries in this analysis was around 72 percent, implying that more than one-fourth of allocated funds went unused. Additionally, the coefficient of variation in execution rates—the ratio of the standard deviation of the execution rate to the mean, expressed as a percentage—is high, about 41 percent. This indicates high levels of country-to-country variation in execution rates. WSS subsector execution rates are similar to those in the water sector overall.

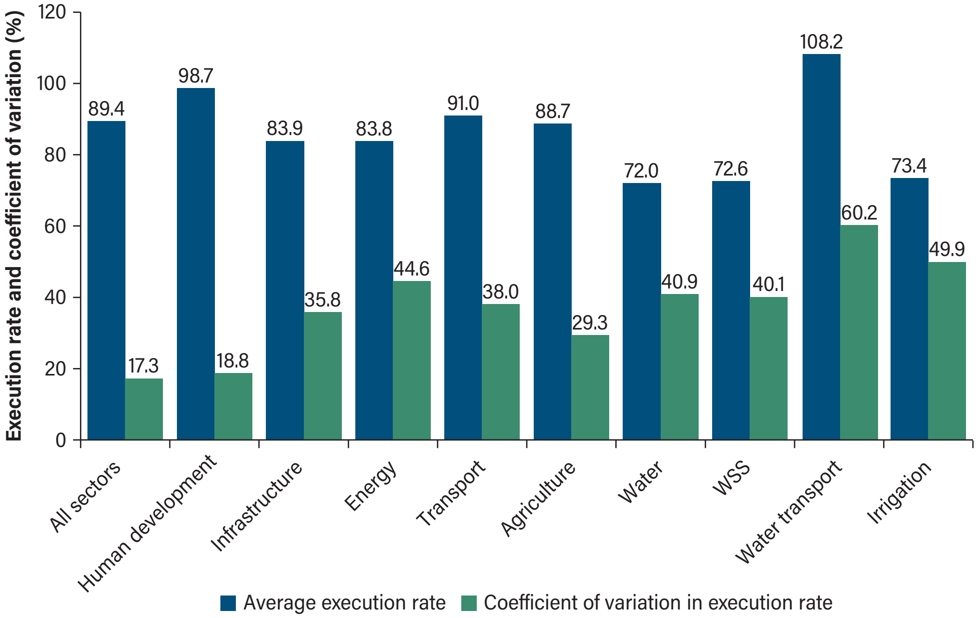
By contrast, the HD sector (social protection, education, and health sectors taken together) has the highest average execution rate (99 percent), with low variation (a coefficient of variation of only 19 percent)—meaning that execution rates in this sector stay consistently high over time and across countries. To put this in perspective, the overall infrastructure sector has an unimpressive average execution rate of 84 percent, with the highest in transport (91 percent) and agriculture (89 percent). Among the infrastructure sectors, however, the water sector has by far the lowest execution rate, driven primarily by the low execution rates in the WSS subsector and, secondly, the high volatility observed in the water transport and irrigation subsectors.

Coefficient of variation as applied to budget execution rates

The coefficient of variation in budget execution rates measures the relative dispersion of the execution rate, that is, the degree of variation in the execution rate relative to its mean. It is a measure of how the data points in a series are distributed (dispersed) around the mean and is a helpful metric for comparing the degree of variation from one data series to another, even when the means are quite different from each other. In essence, it helps to compare the variability in execution rates.

Figure 3.2.2 illustrates the distribution of average execution rates and variability within key sectors. The distribution of water sector execution rates is much flatter demonstrating a high level of variability when compared to social protection, education, and health sectors. The coefficient of variation which is more skewed to the right when compared to the other sector further support the above pattern.

FIGURE 3.2.1 Average Budget Execution Rates and Degree of Variation, by Sector



Source: Authors' elaboration using BOOST database.
Note: WSS = water supply and sanitation.

FIGURE 3.2.2 Distributions of Execution Rates in the Water, Infrastructure, and Human Development Sectors

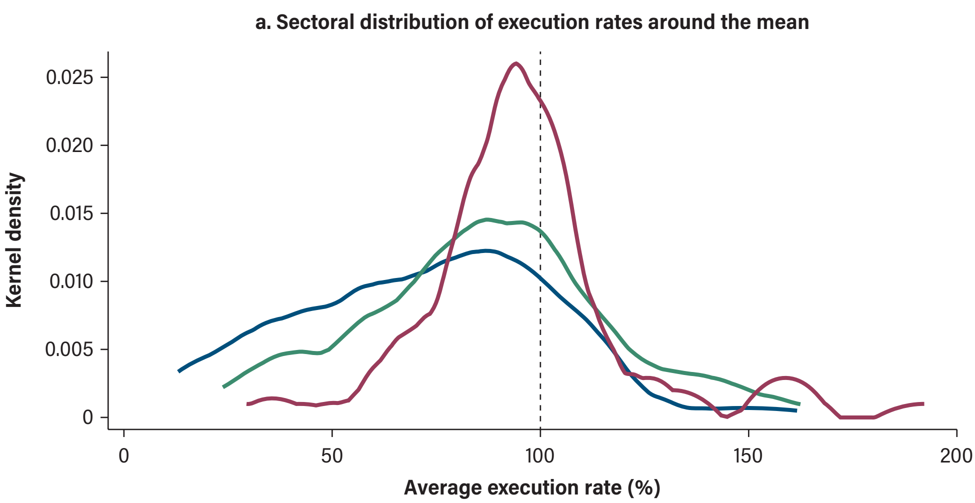


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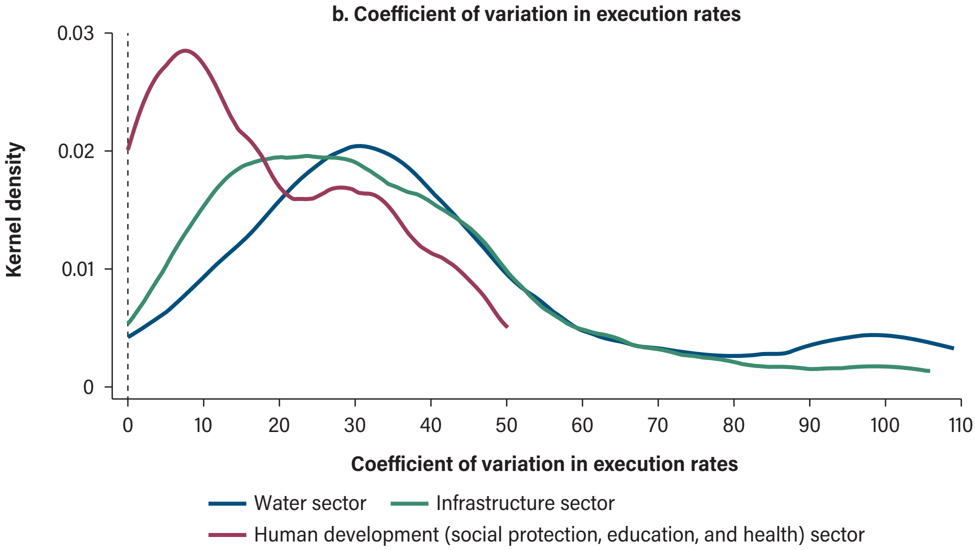
FIGURE 3.2.2 Distributions of Execution Rates in the Water, Infrastructure, and Human Development Sectors (*Continued*)



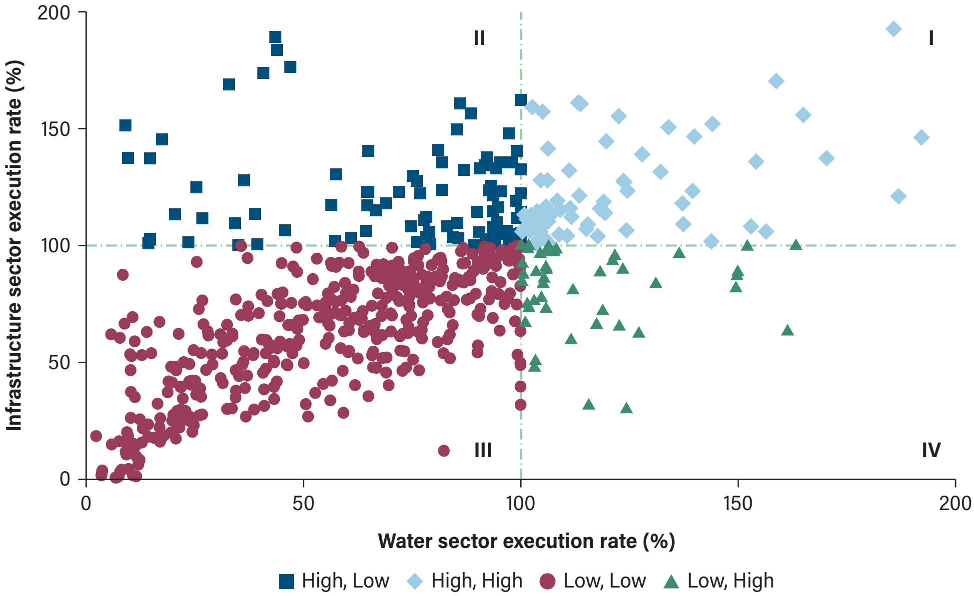
Source: Authors' elaboration using BOOST database (*N* = 65)
Kernel density estimation is a non-parametric method to estimate the probability density function of a random variable, providing a smoothed curve that represents the distribution of data points over a continuous interval, which in this context, reflects the frequency and spread of budget execution rates across different sectors.

Although there are indications that execution challenges are prevalent in all the infrastructure sectors in general, the water sector is a particularly poor performer. A graphic way to depict just how much water sector budget execution rates differ from those in the overall infrastructure and HD sectors is to plot the execution rates of all countries for each available year in quadrants, as in figure 3.2.3. The top panel (panel a) compares the water sector and infrastructure sector execution rates, while panel b compares water sector and HD sector execution rates. In both panels, moving anti-clockwise, quadrant I (top right, light blue) represents high execution rates in both the water sector as well as the comparison sector. Quadrant II (top left, dark blue) represents high execution in the comparison sector and low execution in the water sector. Quadrant III (bottom left, red) represents low execution rates in both, and quadrant IV (bottom right, green) depicts low execution in the comparison sector, high in the water sector.

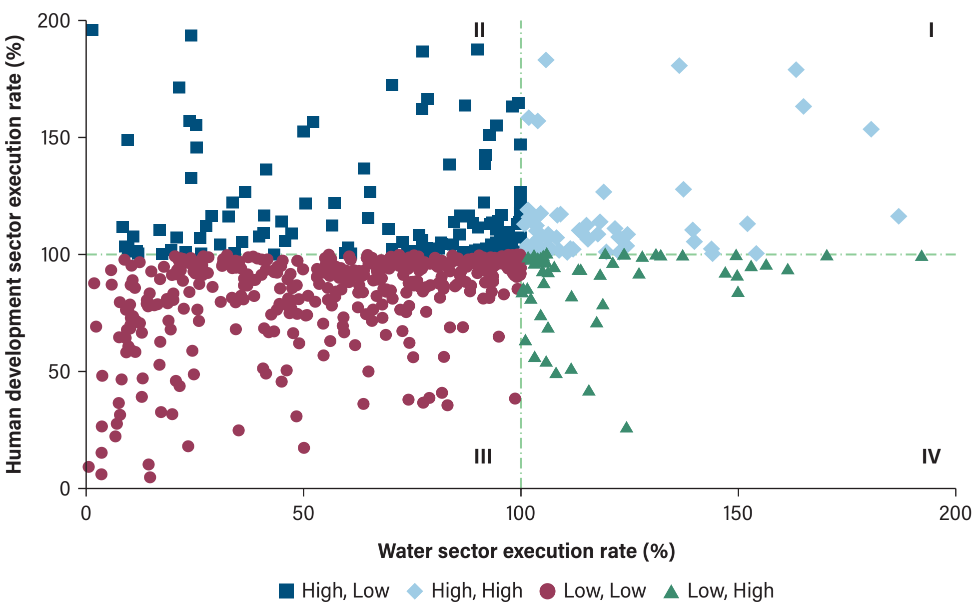
In the comparison with infrastructure (panel a), quadrant I (light blue) has very few scatter dots—meaning there were very few country years in which the water and other infrastructure sectors both had high budget execution rates. Likewise, quadrants II and IV. The great majority of the scatter dots (left bottom, red) indicate low execution in both infrastructure and water sectors, implying the presence of similar structural challenges in both. The dark blue dots in quadrant II show country years in which the water sector faced more challenges than the other infrastructure sectors.

FIGURE 3.2.3 **Water Sector versus Other Sectors: Comparing Execution Rates**

a. Infrastructure sector vs. Water sector



b. Human development sector vs. Water sector



Source: Authors' elaboration using World Bank BOOST database (*N* = 65)

The comparison with human development sector (panel b) tells a similar story: most country years show low budget execution rates in both the water and HD sectors. This possibly highlights common structural issues such as natural disasters or conflicts affecting all the sectors similarly. But it may also reflect common governance and other systemic obstacles driven by institutional and political economy challenges that impede execution, including poor planning, weak management, corruption, constrained resources, infrastructure challenges, and bottlenecks.

Trends in Budget Execution Rates among Countries and Across Time

A more detailed analysis of the BOOST data reveals the same persistent issue in water sector execution rates across different countries. The issue of low budget execution rates is not limited to a handful of countries. Rather, many countries included in the analysis—53 of the 65 countries—seem not to have fully utilized their approved water sector budgets between 2009 and 2020. Seven countries had execution rates higher than 100 percent, meaning they spent more than had been budgeted for (figure 3.2.4).[3] This could well be driven by a push at the national level for greater investments in the sector during the period under study, or an underestimation of sectoral needs in a given year. Four countries have an decadal average execution rate of about 100 percent.

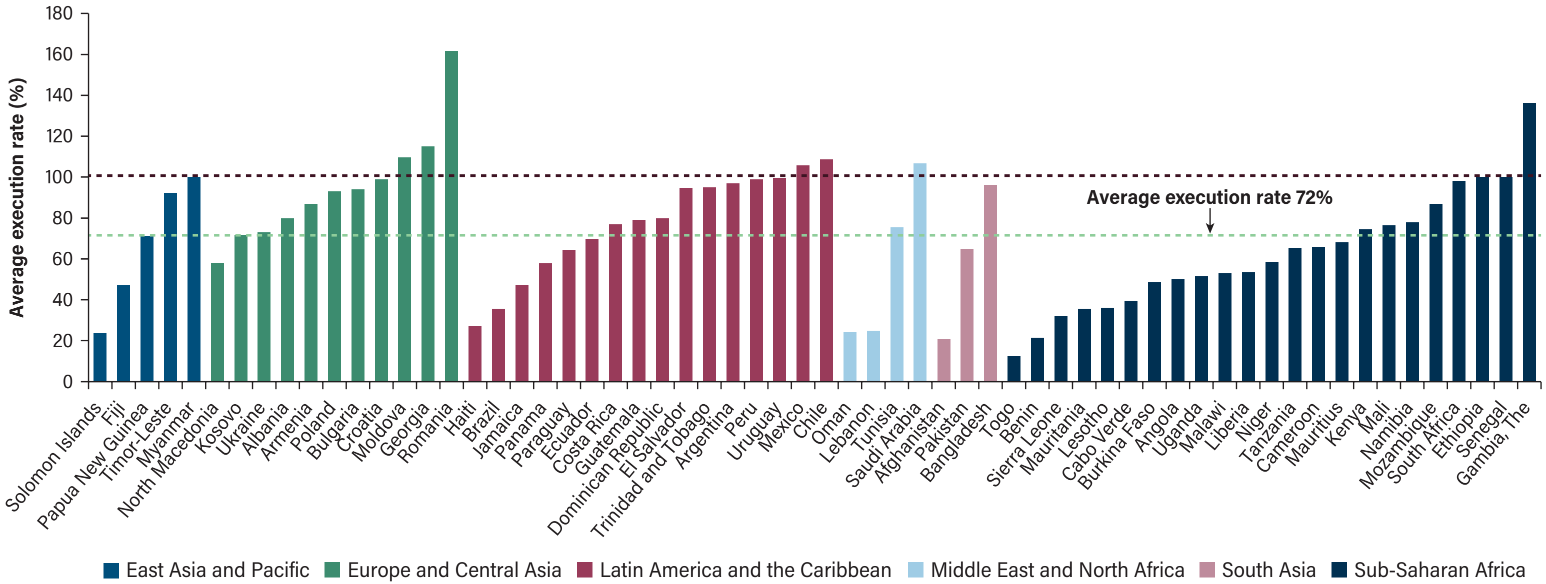
Non-FCV states, with an execution rate of 74 percent, seem to be more effective in utilizing their approved water sector budgets than FCV countries (67 percent).

Additionally, there is significant variation in execution rates within each region. For example, in Sub-Saharan Africa (SSA), Gambia's average execution rate is about 136 percent and Senegal's average execution rate is 100 percent, while Togo's hovers around 12.5 percent. In Latin America and the Caribbean (LAC), Chile's is 108.7 percent, while Brazil has a budget execution rate of 35.4 percent. These intra-regional variations suggest that country-specific rather than region-specific characteristics may play the larger role in influencing or determining budget execution rates. Nonetheless, it also emerges with reasonable clarity that the ECA region, on the whole, has better execution rates than LAC, which in turn has better rates than SSA.

Notably, for the 65 countries, there is a positive correlation between country income level and water sector execution rate. High-income countries have the highest execution rates, averaging 89 percent; low-income countries (LICs) have the lowest average—61 percent (figure 3.2.6).

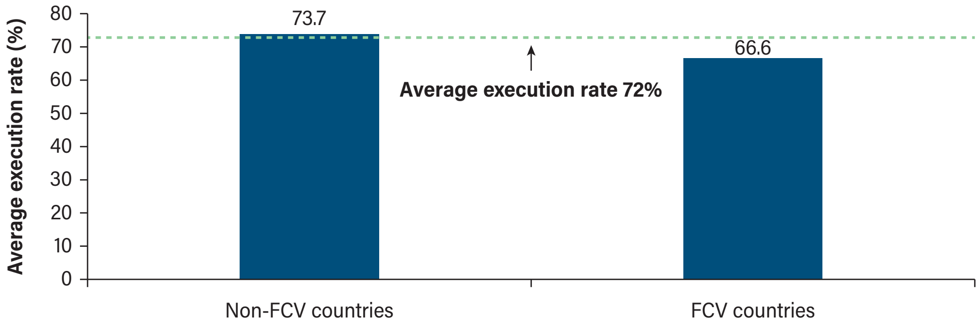
Figure 3.2.5 reveals the difference in budget execution rates between fragile, conflict-affected, and vulnerable (FCV) countries and non-FCV countries. Among the 65 countries, non-FCV states, with an execution rate of 74 percent, seem to be more effective in utilizing their approved water sector budgets than FCV countries (67 percent).

FIGURE 3.2.4 **Average Water Sector Execution Rates, by Country, 2009–20**



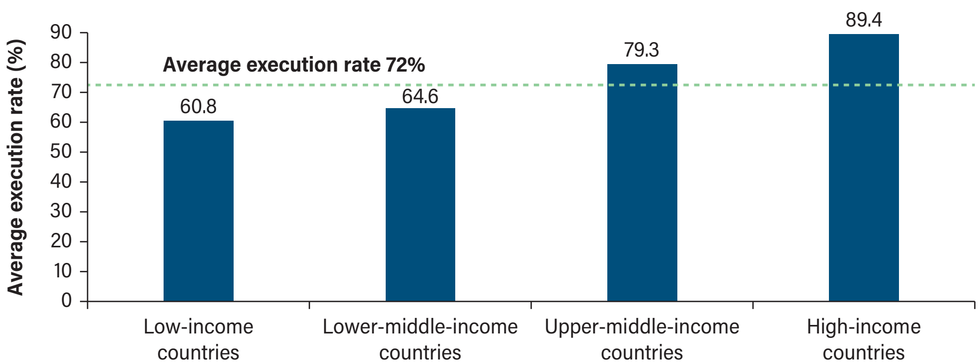
Source: Authors' elaboration using BOOST database (*N* = 65)
Note: EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa. Black dashed line indicates 100 percent full executed, and green dashed line indicates average water sector execution rate of all countries.

FIGURE 3.2.5 Average Water Sector Execution Rates, by Country Fragility Status Group



Source: Authors' elaboration using BOOST database (*N* = 65).
Note: FCV = fragile, conflict-affected, and vulnerable.

FIGURE 3.2.6 Average Water Sector Execution Rates, by Country Income Group

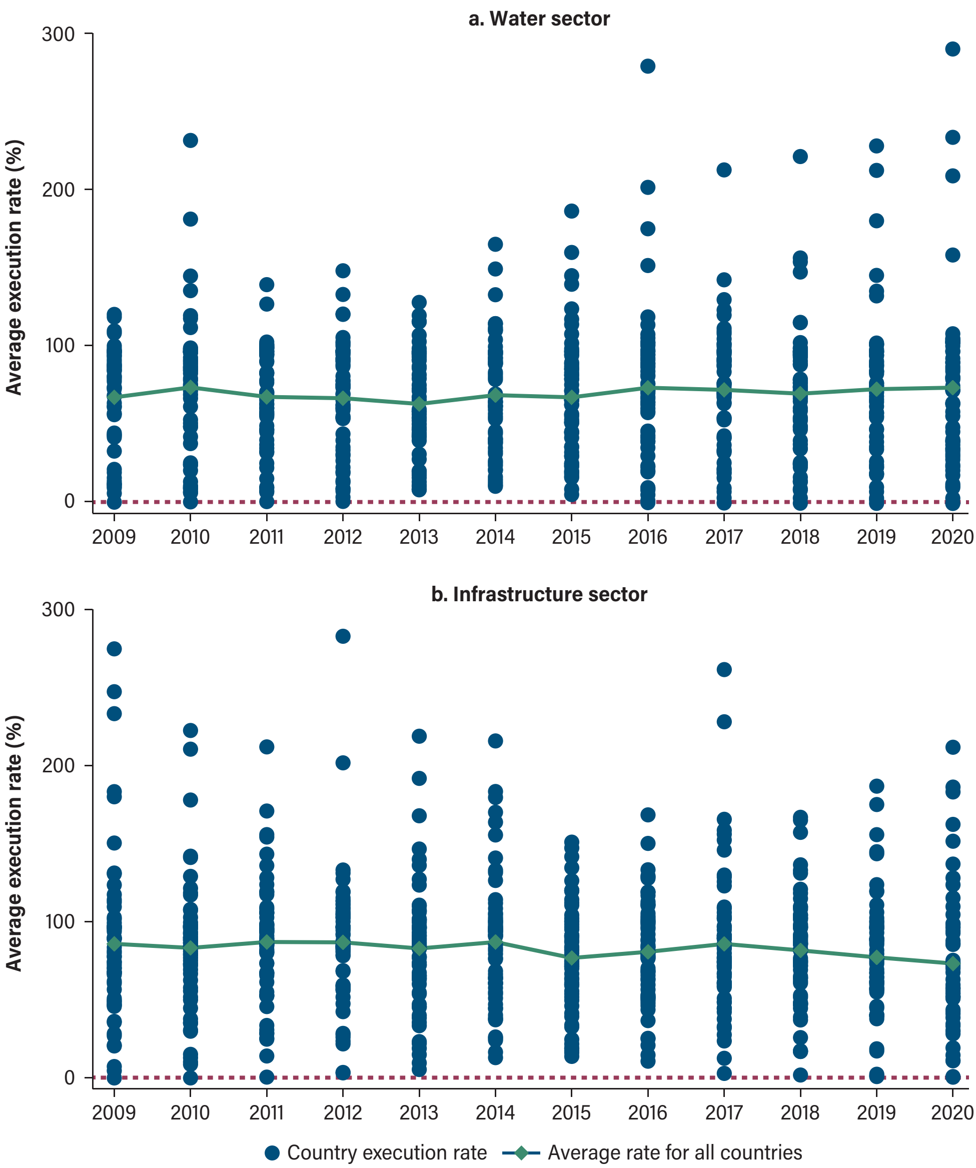


Source: Authors' elaboration using BOOST database (*N* = 65).

In addition, year to year, the average water sector budget execution rate for all countries over the entire 2009–20 period is well below 100 percent but relatively stable—at around 75 percent. The yearly average for all infrastructure sectors is slightly higher, at around 80 percent (figure 3.2.7). Still, despite being relatively stable throughout the years, there is considerable country-to-country variation in budget execution rates within each year, suggesting again that country-specific characteristics drive this variation.

Indeed, countries with both high and low execution rates suffer from significant variability over time. Figure 3.2.8, which depicts relative country rankings, plots the execution rates of each country along a horizontal line—for the infrastructure sector, and for the water sector. Each blue dot represents a country's decadal average execution rate. The green dots represent its execution rates in the water sector (panel a) and infrastructure sector (panel b) for each year. The span of the green dots thus represents the range of variation over the entire period. It can be observed that even for higher-ranking countries (blue dot close to the 100 percent mark), the range of variation across the years is still high. We notice high variation in all country income groups. Moreover, the source of the variation is from within-country specificities rather than between-country or yearly variability. It should also be noted that budget execution rate above 100 percent is not a good indicator of performance: when a country's budget execution rate is above 100 percent, it is a reflection of poor planning or unintended spending including due to cost escalation or natural disasters. In principle, countries should be aiming at a budget execution rate of 100 percent.

FIGURE 3.2.7 Annual Average Execution Rates across Countries



Source: Authors' elaboration using BOOST database. Each year is represented by a set of hollow bubbles, each indicating the execution rate of a single country. The solid dots represent the average execution rate across all countries for that year.

FIGURE 3.2.8 **Country Rankings by Decadal Average Execution Rates**

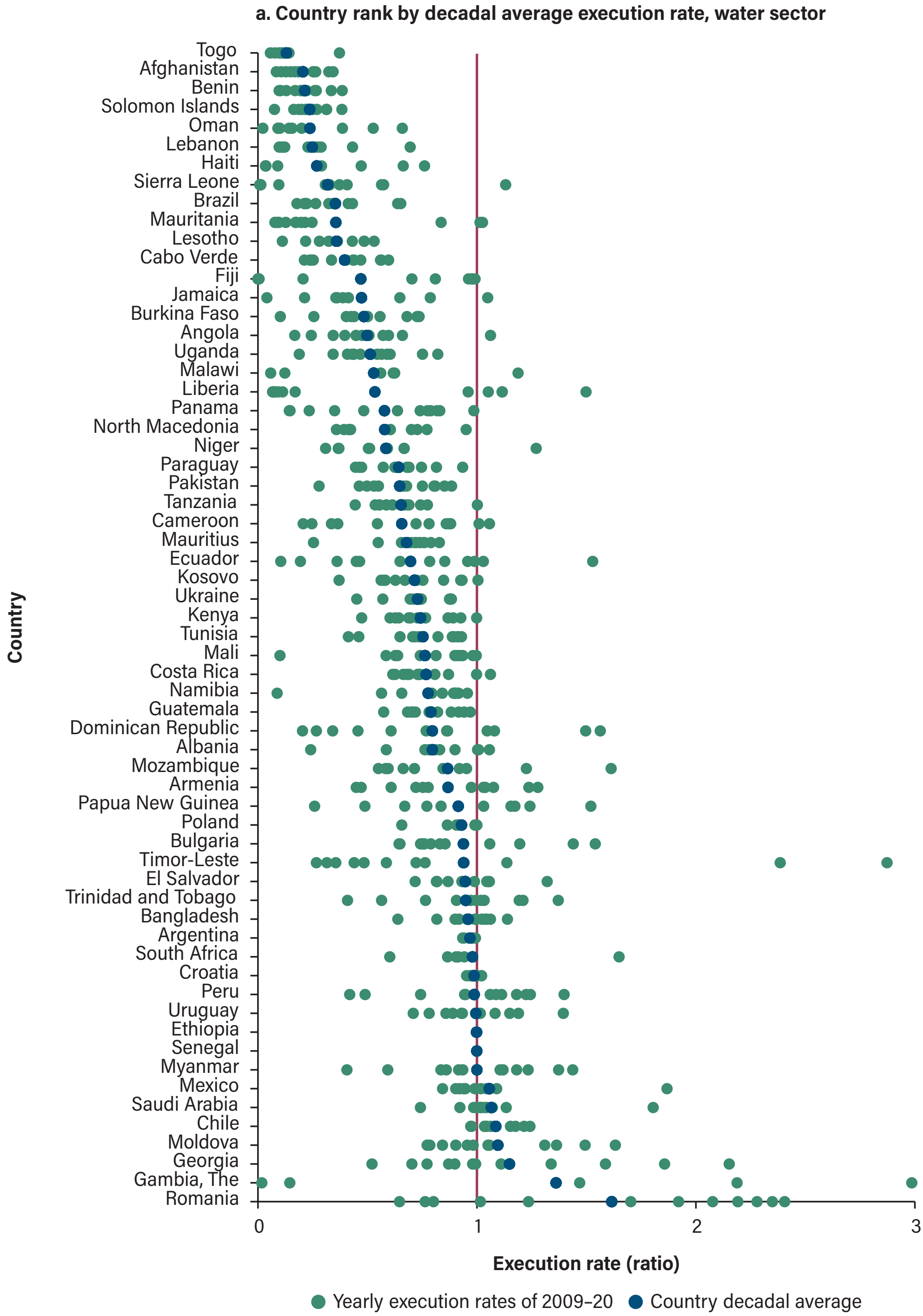


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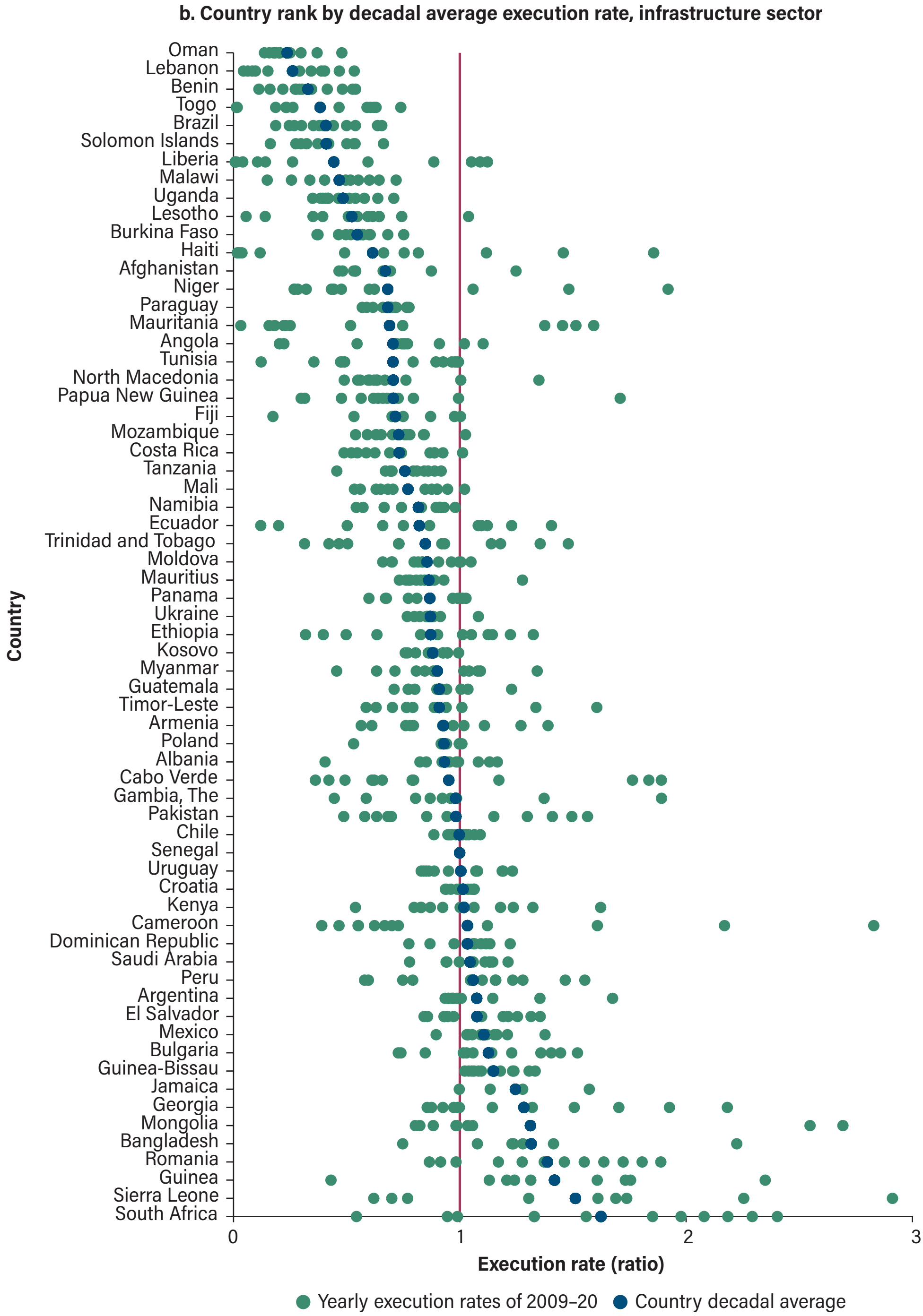
FIGURE 3.2.8 **Country Rankings by Decadal Average Execution Rates (*Continued*)**



Source: Authors' elaboration using BOOST database (*N* = 65)

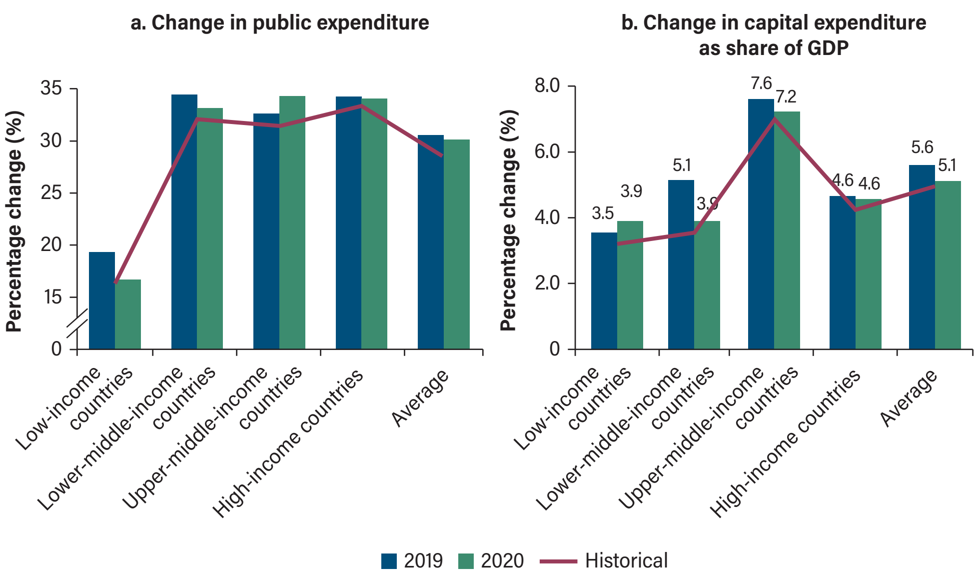
COVID-19's Impact on Water Sector Public Spending

The COVID-19 pandemic significantly affected fiscal policies in developing countries. It placed heavy pressure on fiscal resources globally, exposing and amplifying existing long-term fiscal sustainability issues. This section offers insights into the pandemic's fiscal impact on public expenditure, particularly water sector spending. The analysis is based on the BOOST database with 2020 data from 46 developing countries,[4] for which granular execution data were fully collected, a necessary precondition to assess the fiscal impact of COVID on expenditure composition.

The pandemic triggered significant revenue loss, with 2020 GDP declining 2.4 percentage points on average in most developing countries. This was driven primarily by lower tax revenues during the crisis (Aslam et al. 2022; Ţibulcă and Ţibulc 2021). Governments had to reprioritize development, service delivery, and administrative activities in an environment of tight constraints and global supply shocks. This widened developing-country fiscal deficits, which averaged almost 2 percent of GDP in 2020 and resulted in an uneven allocation of resources across sectors (IMF 2021).

Overall, as shown in figure 3.2.9, in the sample countries, public spending as a share of GDP slightly decreased in 2020 from 2019, especially in the LICs. This was perhaps due to significant spending reductions by governments, in response to widespread lockdowns throughout the world. For example, lower-middle-income countries reduced their capital spending by more than 1.1 percentage points on average, although capital spending increased slightly among the low-income countries.

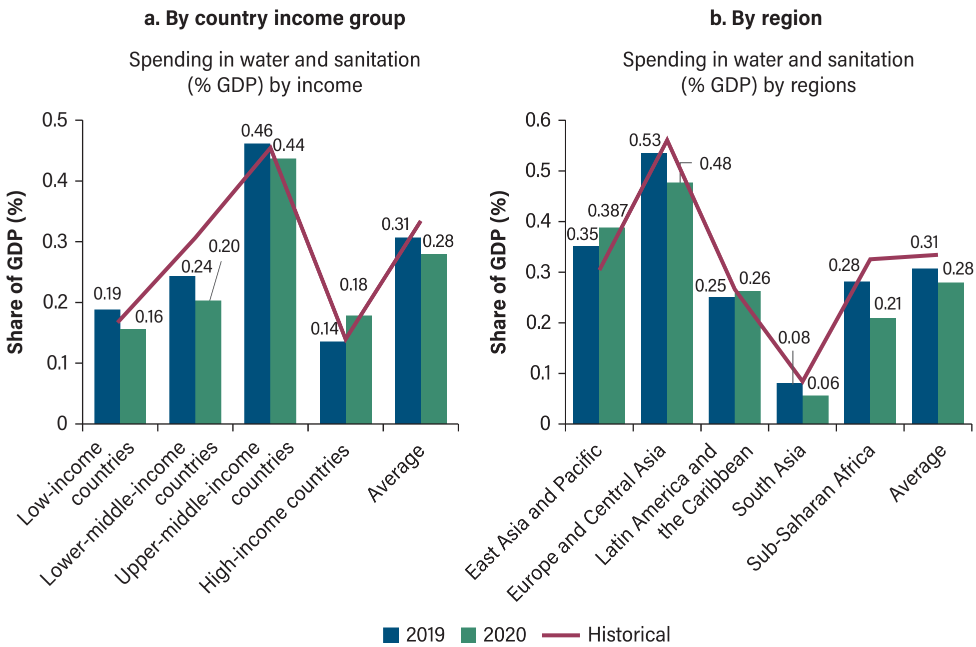
FIGURE 3.2.9 Changes in Public Expenditure and Capital Expenditure, by Country Income Group, 2019–20



Source: Authors' own elaboration using BOOST database

With few exceptions, spending as a share of GDP decreased in 2020 in most sectors, compared to not only 2019 but also historical levels, with the largest decreases in the agriculture and infrastructure sectors. Discretionary spending such as capital and maintenance expenditures fell the most, with potential long-term effects on the capital base. Irrigation spending decreased by 27 percent in 2020 while water and sanitation sector spending fell by 9 percent vis-a-vis 2019 levels. The decrease in water and sanitation spending is unexpected since water and sanitation provision, particularly handwashing, was strongly advocated as the first line of defense against the spread of the virus. Regionally, SSA, followed by ECA, recorded the most significant percentage point drops in WSS spending, although South Asia had the largest year-to-year percentage change (figure 3.2.10b).

FIGURE 3.2.10 Spending in WSS Subsector as a Share of GDP, 2019–20

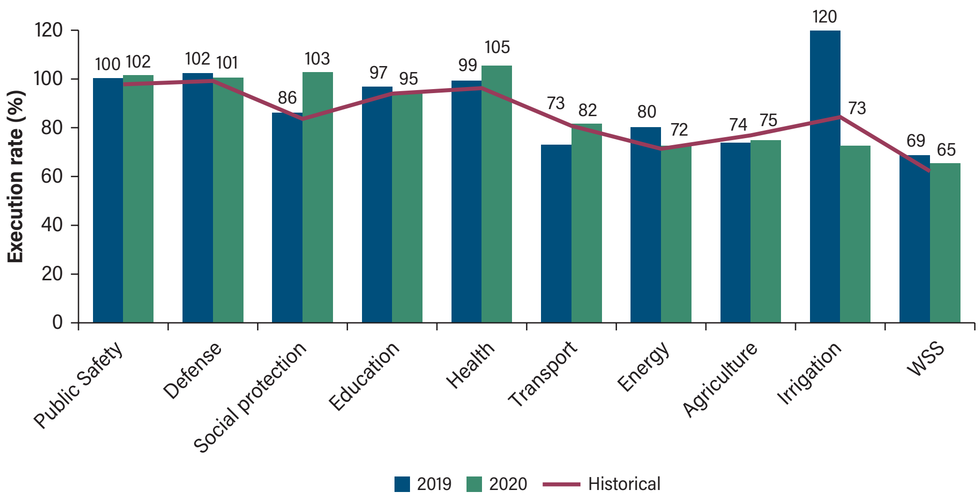


Source: Authors' elaboration using BOOST database.

As a result, budget execution rates in 2020 fell in several sectors (figure 3.2.11). The WSS execution rate dropped by 4 percentage points from 2019, making it the subsector with the lowest execution rate (65 percent). Irrigation experienced the largest percentage decrease in execution rates, at 39 percent.[5]

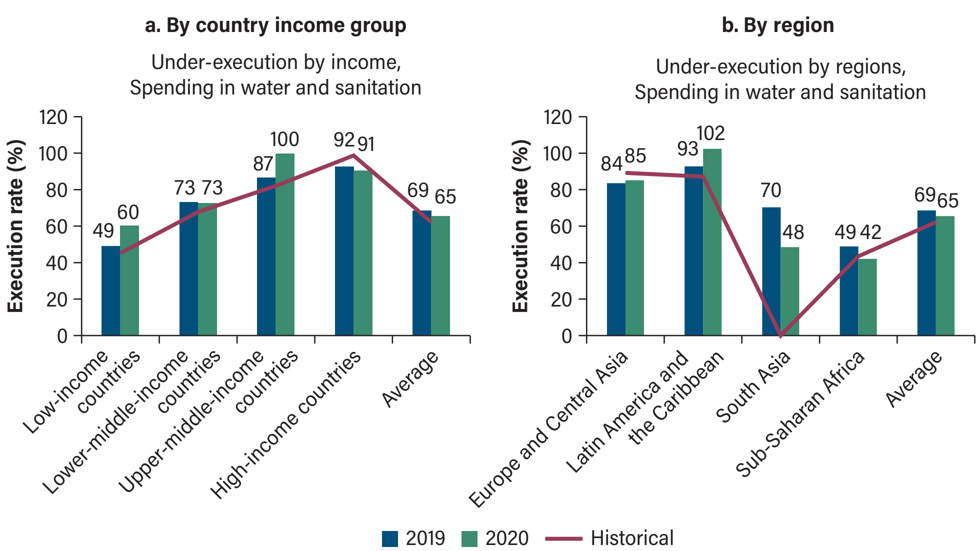
There was also some variability in WSS execution rates across both country income groups and regions between 2019 and 2020. Lower-middle-income countries experienced a marginal decline in execution rates, potentially indicating a trend toward a reprioritization of expenditures in this income group. In contrast, execution rates in LICs rose, albeit from a low baseline, and upper-middle-income countries reached a 100 percent execution rate (figure 3.2.12a). This increase in execution rates in LICs and MICs was quite pronounced compared to their historical averages. Regionally, the most significant drop in WSS execution rates was in South Asia, followed by Sub-Saharan Africa, which continued to have the lowest execution rates.

FIGURE 3.2.11 Changes in Budget Execution Rates, by Sector, 2019–20



Source: Authors' elaboration using BOOST database
Note: WSS = water supply and sanitation.

FIGURE 3.2.12 Changes in Budget Execution Rates in the WSS Subsector, 2019–20



Source: Authors' elaboration using BOOST database
Historical execution rates cover the period between 2013 and 2020, except for South Asia, which is between 2017 and 2020 owing to data constraints.

Correlates of Budget Execution

The data presented in the preceding sections show considerable variation in budget execution rates within and across countries, driven primarily by unique and specific country-level characteristics. To further understand the wide variations among the countries, we examine the factors that may underlie execution rates in the water sector. We focus first on the relationship between the execution rate and variables that are related to country income level and political and institutional arrangements.

We then employ an econometric approach, taking the execution rate as the dependent variable and a set of control variables as the independent variables, to identify the potential determinants of budget execution. The seven primary control variables are the logarithm of GDP per capita, logarithm of the net barter terms-of-trade index, logarithm of per capita debt service on external debt, urbanization rate, population density, general government gross debt-to-GDP ratio, and fiscal balance-to-GDP ratio. In addition to economic factors, this study carefully includes variables for governance, institutions, culture, conflicts, and fragility. These additional variables are included in recognition that institutional and governance factors, along with the rate of economic growth, size of the public debt, and level of fiscal deficit, can indeed have profound impacts on budget execution.

GDP PER CAPITA DOES NOT NECESSARILY MATTER

This section first examines the correlation between GDP per capita and the execution rate in the water, infrastructure, and HD sectors and the WSS subsector using simple scatterplots. A key finding here is that there is no discernable pattern established in the relationship between GDP per capita and the budget execution rate in any sector—be it water, WSS, infrastructure, or HD. As illustrated in figure 3.2.13, the fitted lines based on bivariate Ordinary Least Squares (OLS) regressions indicate a weak association between budget execution rates and GDP per capita. Interestingly, high-income and upper-middle-income countries in the sample also display high levels of dispersion in execution rates, comparable to those of LICs. This means that sheer economic development, important as it is, will not necessarily offer a silver bullet solution to the budget execution problem in the water, infrastructure, and HD sectors. There is a need for the recognition that budget execution in the water sector is by itself a challenge that has to be addressed in its own right. Low absorptive capacity is more of a systemic challenge that needs to be resolved through factors beyond just economic progress.

There is no discernable pattern established in the relationship between GDP per capita and the budget execution rate in any sector—be it water, WSS, infrastructure, or HD.

It is also important to distinguish between poor execution rates and its qualitative impact in high-income countries versus that in the lower-middle-income or low-income countries, although they are numerically similar. High-income countries have much higher-quality infrastructure and service levels, so the impact of limited utilization of water budgets will be less than in LICs or MICs, where access to even basic services remain a formidable challenge.

FIGURE 3.2.13 Correlation between Country Income Level and Execution Rates in the Water, Infrastructure, and HD Sectors and WSS Subsector

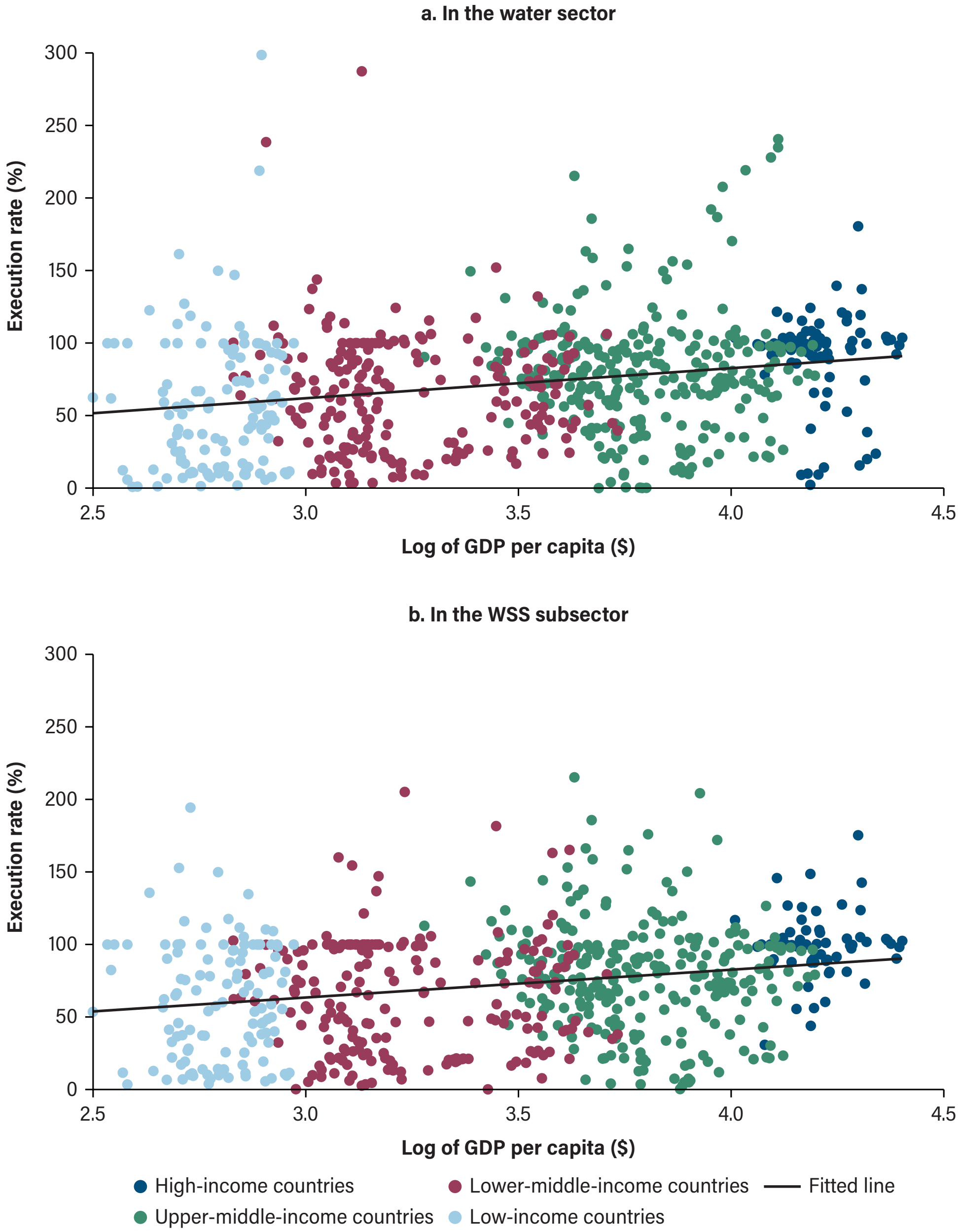


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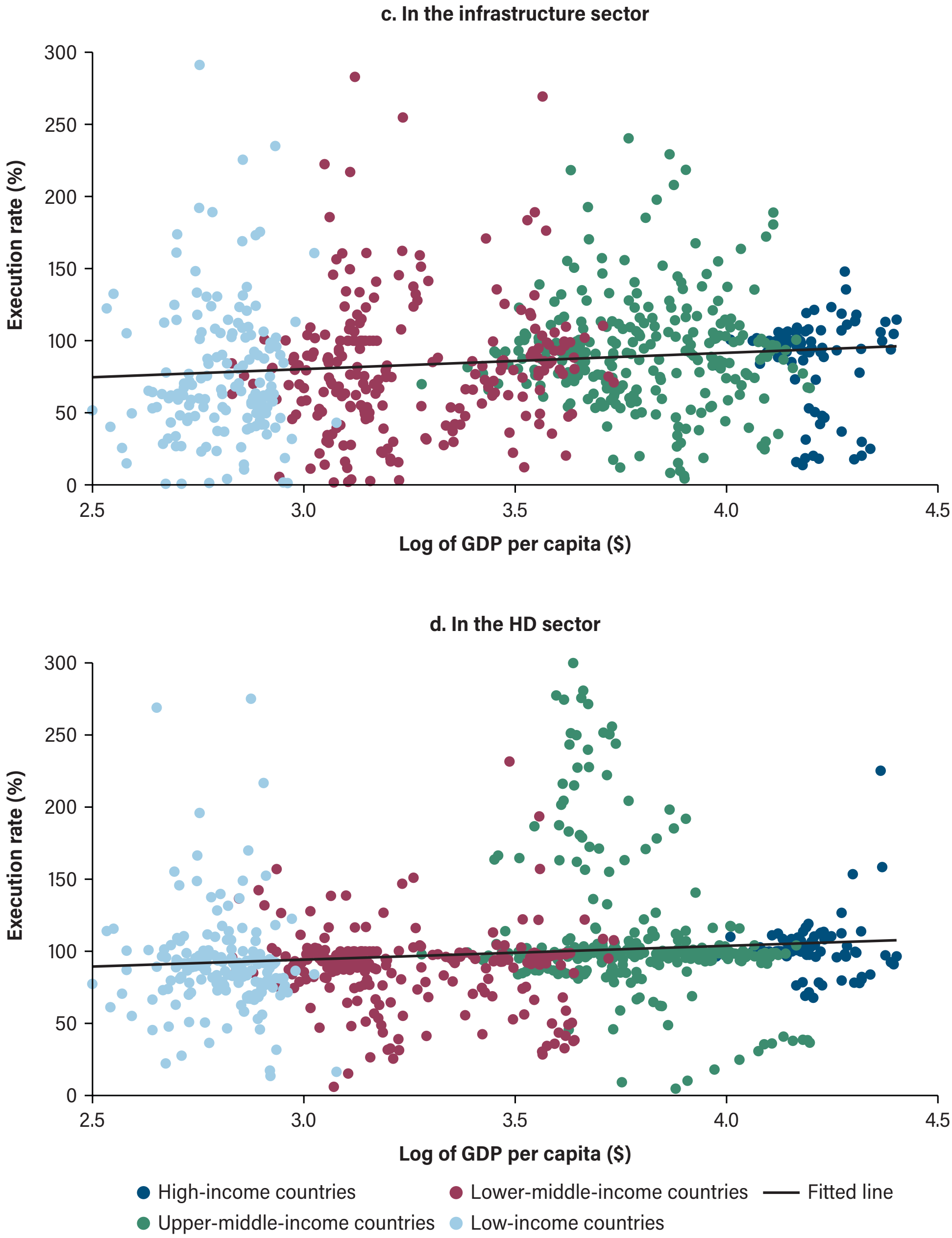
FIGURE 3.2.13 Correlation between Country Income Level and Execution Rates in the Water, Infrastructure, and HD Sectors and WSS Subsector (*Continued*)



Source: Authors' elaboration using BOOST database (*N* = 65).
Note: WSS = water supply and sanitation.

The scatterplot in panel a of figure 3.2.13 reveals a slightly ascending fitted line, which implies a positive correlation between a country's income level and its budget execution rates in the water sector. This observation is consistent with the pattern earlier depicted in figure 3.2.6—average water sector execution rates by country income groups.

THE ROLE OF GOVERNANCE

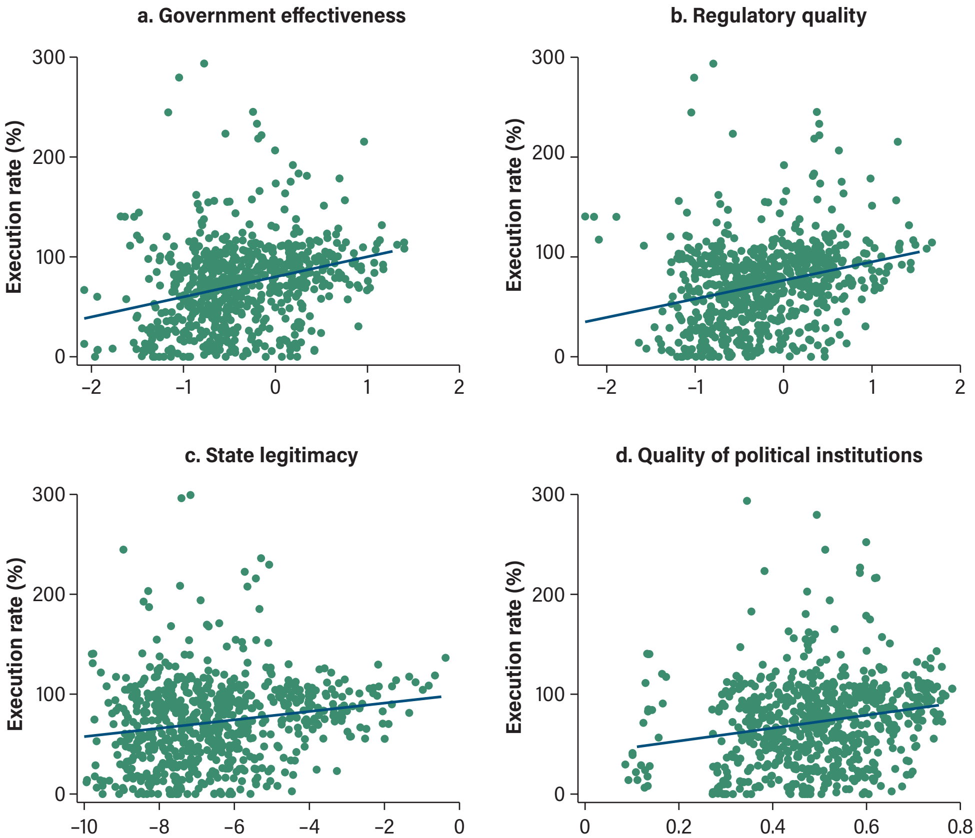
Since economic factors and conditions have limited explanatory power in illuminating the disparity and dispersion in execution rates observed within and across countries, it is important to explore the importance of political and institutional factors because they shape all aspects of the planning, preparation, and implementation of programs and projects. Many have argued that vigorous national economic performance is primarily a product of an institutional and political environment that promotes economic freedom, the rule of law, and better governance (Helpman 2008; Robinson and Acemoglu 2012).

More effective governance, greater regulatory quality, higher state legitimacy, and superior quality of political institutions improve budget execution rates in the water sector.

In addition, a country's political and institutional environment can significantly influence its fiscal or budgetary performance (Alesina and Perotti 1995; Edin and Ohlsson 1991; Mawejje and Odhiambo 2020; Roubini and Sachs 1989; Wehner and de Renzio 2013). It is therefore plausible that poor budget execution in various sectors, including water, could partly be explained by a wide range of political economy factors that can include weak governance, corruption, fragility and conflicts, lack of effective institutions, weak accountability, patronage systems, state capture by elites, and lack of transparency.

Figure 3.2.14 presents a positive relationship between budget execution and some indicators that measure governance, regulation, legitimacy, and institution. Government effectiveness measures the quality of inputs-the quality of public services, civil service, policy formulation and implementation, and the credibility of a government's commitment to improving or maintaining these aspects- required for the government to be able to produce and implement sound policies and deliver public goods. Regulatory quality includes a measure of the incidence of market-unfriendly policies, such as price controls or inadequate supervision. Level of State legitimacy- a measure of corruption and the lack of representativeness in the government that undermines the social contract- measures how representative the state is, as reflected in the confidence its citizens place in it and their recognition of its right to rule. And quality of political institutions measures the freedom to organize and participate in political processes effectively. More effective governance, greater regulatory quality, higher state legitimacy, and superior quality of political institutions improve budget execution rates in the water sector.

FIGURE 3.2.14 Correlation between Water Sector Execution Rate and Governance, Regulation, State Legitimacy, and Institutions



Source: Government effectiveness and regulatory quality from the Worldwide Governance Indicators (WBGI); State legitimacy from the Fragile States Index; performance of political institutions from Kuncic (2014).
The x-axis in each plot represents standardized scores for governance indicators, which are coded in a positive direction.

DETERMINANTS OF BUDGET EXECUTION

After cautiously taking into consideration the potential for multicollinearity among the various interrelated institutional and political variables, a selected set of variables were included as correlates of budget execution rates.[6] The correlation table, presented in table D.1, provides a pairwise correlation of the variables used for variable selection to minimize multicollinearity—which, if present, would have the effect of making it harder to trace or determine the individual effects of each independent variable on our dependent variable.

Starting from the selection between fixed effects, random effects, and pooled OLS, a series of econometric tests were conducted, including the Hausman test and Breusch-Pagan Lagrange multiplier (LM) to test whether the data met the assumptions of running a pooled OLS to study the causal relationship between budget execution and political/economic variables (table 3.2.1). The detailed assumptions, examinations, and regression outputs can be found in appendix E.

As indicated in the regression table (table 3.2.1)—more specifications are presented in tables E.2–E.4)—none of the economic variables have the statistical power to explain the variation in execution rates across all sectors. However, governance, regulatory, and political variables all have the expected signs of coefficients, and many have strong statistical significance. Government effectiveness is statistically significant at a 1–10 percent level across different sectors, offering persuasive evidence of the importance of good governance. More explicitly, as shown in figure 3.2.15, as the government effectiveness index moves from the lowest quintile to the second-lowest quintile, the execution rate in the water sector increases from 51 to 70 percent, and the execution rate in WSS rises from 50 to 70 percent.

Thus, improvements in governance effectiveness that address issues of state legitimacy and the quality of political institutions can help strengthen budget execution. By contrast, greater levels of fractionalization, fragility, and conflict obstruct budget execution. Improving governance and institutions is a challenging and long-drawn-out endeavor that is well beyond the scope of the water sector alone. Meanwhile, other measures to improve leadership, management, and administrative and implementation procedures—from approval to procurement and public financial management—should be prioritized to improve sector performance. Intensive monitoring and providing coordinated and targeted assistance to identified high-risk projects, may be warranted.

Further, focusing more attention on high-risk projects that are likely to experience delays—such as large capital or high-priority projects and those that have issues during preparation—can improve execution. There is also a need to improve the capacity of human resources and staff morale, which can go a long way toward improving budget execution and achieving sector goals.

Conclusion and Discussion

Focusing on budget execution rates in the water sector, this chapter compared sectoral execution rates in the infrastructure, water, and HD sectors to evaluate time trends and identify potential differences among countries and regions. Additionally, it explored the determinants of budget execution, especially GDP growth, governance, regulatory robustness, institutional capacity, and state legitimacy, and examined the impact of COVID-19, comparing data from the 2019–2022 period.

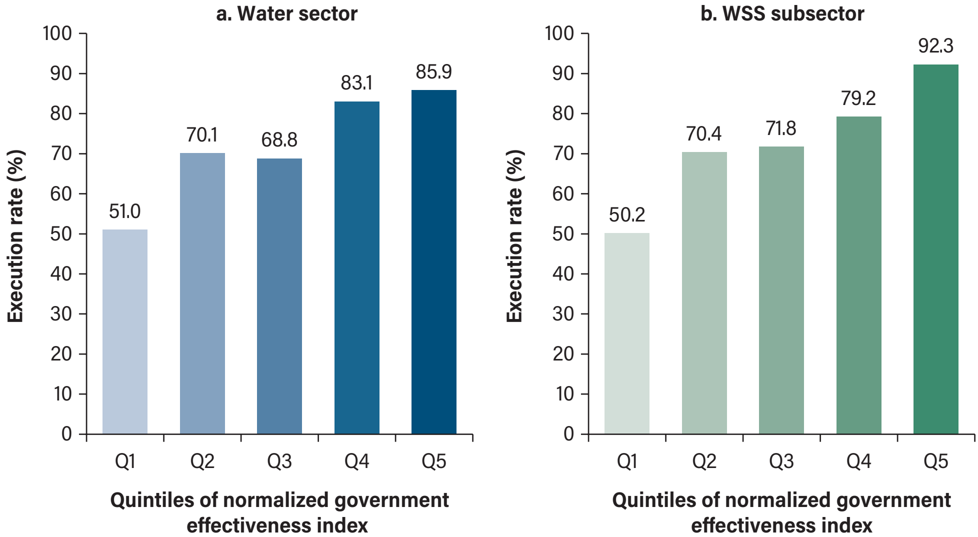
TABLE 3.2.1 Determinants of Budget Execution Rate, Pooled OLS

	Execution rate								
	Total Public Expenditure	Infrastructure	Water	WSS	Energy	Transport	Agriculture	Irrigation	HD
Log of GDP per capita	0.0234 [0.0886]	-0.154 [0.214]	-0.108 [0.201]	-0.270 [0.203]	-0.233 [0.218]	-0.174 [0.203]	-0.213 [0.180]	0.494* [0.287]	0.144 [0.187]
Log of terms of trade	-0.315** [0.142]	-0.180 [0.367]	0.0996 [0.219]	-0.146 [0.269]	0.500* [0.294]	-0.845** [0.385]	0.0180 [0.225]	1.284*** [0.418]	-0.490* [0.249]
Log of debt service per capita	0.0437 [0.0510]	0.0637 [0.119]	0.146* [0.0836]	0.130 [0.0962]	0.135 [0.100]	0.0927 [0.113]	0.0676 [0.0893]	0.150 [0.173]	-0.0462 [0.0857]
Government debt	-0.00150 [0.00115]	-0.00186 [0.00258]	-0.00260 [0.00167]	-0.00255 [0.00177]	-0.000881 [0.00283]	-0.00523** [0.00208]	0.00180 [0.00304]	-0.000190 [0.00291]	0.00229 [0.00245]
Fiscal balance	0.000754 [0.00682]	-0.00419 [0.0121]	-0.00389 [0.0108]	-0.00830 [0.0102]	0.0146 [0.0150]	-0.00364 [0.0139]	0.0259* [0.0132]	0.00965 [0.0181]	0.000614 [0.00966]
Urbanization rate	0.000324 [0.00136]	0.00303 [0.00326]	-0.00193 [0.00314]	0.000169 [0.00270]	0.00231 [0.00272]	0.00173 [0.00357]	-0.00215 [0.00302]	-0.0154*** [0.00403]	-0.000485 [0.00289]
Log of population density	0.00973 [0.0310]	-0.0923 [0.0974]	0.0985 [0.0742]	0.0530 [0.0716]	0.0949 [0.0842]	0.0439 [0.101]	0.0185 [0.0556]	0.381** [0.148]	-0.00327 [0.0627]
Government effectiveness	0.0705* [0.0399]	0.258** [0.103]	0.156* [0.0904]	0.203** [0.0972]	0.0226 [0.108]	0.155 [0.105]	0.135* [0.0777]	-0.139 [0.177]	0.266** [0.131]
Religious fractionalization	-0.0119 [0.0688]	-0.272 [0.286]	-0.532*** [0.180]	-0.438** [0.174]	-0.405** [0.166]	-0.231 [0.297]	-0.207 [0.184]	-0.894*** [0.273]	0.169 [0.170]
State legitimacy	-0.0184 [0.0217]	-0.0578 [0.0433]	-0.0607* [0.0329]	-0.0153 [0.0326]	-0.0811* [0.0450]	-0.0116 [0.0394]	0.00409 [0.0295]	-0.0720 [0.0478]	-0.0904* [0.0453]
Fragile, conflict-affected, and vulnerable status	0.0268 [0.0527]	0.140 [0.130]	-0.0778 [0.0936]	-0.0831 [0.101]	0.0360 [0.107]	0.193 [0.133]	0.0392 [0.107]	-0.0573 [0.127]	0.140* [0.0819]
Quality of political institutions	-0.107 [0.309]	0.423 [0.574]	0.655 [0.528]	0.0966 [0.447]	0.969 [0.720]	0.461 [0.536]	0.249 [0.522]	1.142* [0.625]	0.334 [0.581]
Constant	1.349*** [0.418]	1.328 [1.126]	0.205 [0.771]	1.809** [0.767]	-0.615 [0.957]	2.865** [1.241]	1.563* [0.808]	-4.403** [1.672]	0.687 [0.858]
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
***R*-squared**	0.0980	0.104	0.207	0.181	0.0916	0.133	0.0769	0.264	0.195
Obs.	588	562	529	498	526	540	562	302	58"

Source: Expenditure data from BOOST (2009–20); GDP (current, $), Net barter terms-of-trade index (2000 = 100), debt service on external debt, public and publicly guaranteed (PPG) (total debt service (TDS) current), urban and total population and population density from WDI; General government gross debt (percent of GDP) and fiscal balance (percent of GDP) from Fiscal Space (Kose et al. 2017); Government effectiveness and regulatory quality from the WBGI; Fractionalization from (Alesina et al. 2003); Fragile, conflict-affected, and vulnerable status country list per year from the World Bank (Harmonized List of Fragility, Conflict and Violence Countries n.d.); State legitimacy from Fragile States Index; Performance of political institutions from Kuncic (2014). All variables are coded in a positive direction.

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Simple pooled OLS with robust standard errors clustered at the country level. PPG = Public and publicly guaranteed; WDI = World Bank Development Indicator; WBGI = Worldwide Governance Indicators; GDP = Gross domestic product.

FIGURE 3.2.15 Government Effectiveness and Execution Rates in Water Sector and WSS Subsector



Source: Authors' calculation using BOOST database and World Bank Governance Indicators
Note: WSS = Water supply and sanitation.

In the sample of 65 countries analyzed, the execution rate in the water sector was significantly lower than in the HD sector, or in other infrastructure-heavy sectors such as transport and agriculture. Within the water sector, water transport showed relatively better execution rates than WSS and irrigation. Exploring the determinants of budget execution in the water sector, however, unearthed no clear correlation with country income level, expressed as GDP per capita. But government performance and institutional-related variables had a significant association with budget execution rates.

The water sector, overall, is characterized by low budget execution rates. Among the possible explanatory factors, low absorptive capacity stands out and remains a prime challenge if water sector budget execution rates are to improve. Big infrastructure projects can take a long time to complete (IMF 2020); and in infrastructure sectors like water, where capital spending far exceeds salaries and wage bills, spending depends on the speed with which investment project implementation occurs. Complications in budget preparation, the transfer of resources to line ministries and implementing agencies, and bureaucratic procurement processes with laborious requirements and multiple approval stages can significantly delay their implementation. Indeed, a new study of some 16,000 major infrastructure projects around the world estimates that only 8.5 percent finish on budget and on time (Flyvbjerg and Gardner 2023).[7]

In the water sector, for example, dam construction projects take 45 percent longer to complete than intended (Ansar et al. 2014). Finally, the source of funds and high transaction costs caused by fragmented donor activity, the slow pace of fiscal decentralization, or an inappropriate mix of recurrent and capital funding, can also significantly affect the sector's absorptive capacity (World Bank 2012).

This is one of the reasons why a high execution rate—that is, spending close to, or even over, the approved amount—may not necessarily indicate better results or better fiscal discipline. Although countries with an execution rate of over 100 percent may have supplemental budgets within a fiscal year to account for *ad hoc* policy changes and various shocks, it could also imply inefficiencies in public spending or weaknesses in the budgetary planning system, especially when countries are scaling up public investments. Implementing multiple new projects simultaneously requires a varied set of technical and managerial resources that cannot be expanded or augmented in the short term, because the development and acquisition of technical/managerial resources takes time, and because absorptive-capacity constraints and supply bottlenecks may inflate costs and delay the project (Flyvbjerg 2009; Gurara et al. 2021).

Additionally, evidence suggest that project cost increases are typically larger if they are appraised and undertaken during periods of high public investments (IMF 2020). It has been found that, in LICs, a 3 percent increase in public investments as a share of GDP is associated with an increase of 6 percent in the project appraisal cost (IMF 2020). Such cost increases can contribute to overspending of budgetary allocations, resulting in a budget execution rate exceeding 100 percent.

Another factor to bear in mind is that the budget execution rate merely refers to the proportion of the budget that was spent on the project; it does not necessarily indicate how well the project was implemented, the outcomes achieved, or the reasons why the execution rate went over or under 100 percent. It just offers a number, with no visible caveats attached. So, to successfully address the limitations of using the budget execution rate as a proxy for budget implementation quality, there is a need to develop more comprehensive indicators that consider the budget implementation process and implementation quality.

The reason is that the budget execution rate does not capture the complexity, diversity, and heterogeneity of the budget implementation processes, which in turn depends on factors such as the capacity of the sector to absorb the available budget. Further, it also may not fully reflect the impact of external factors, such as political instability or natural disasters, on budget implementation (Mawejje and Odhiambo 2020). In short, budget execution rates should therefore be used cautiously and in conjunction with other indicators to provide a more comprehensive understanding of the budget implementation process.

Using budget execution rates as a metric of performance also has the limitation that it only provides a snapshot of spending at the end of the fiscal year. However, some public projects span multiple years, and the approved budget may have been allocated during the initial year of the project. This means that the execution rate at the end of a particular year may not accurately reflect the progress of the project. For example, a low execution rate at the end of the first year of a multi-year project could be low because most of the spending was expected to occur, and did occur, in subsequent years. So even though the execution rate turned out to average 100 percent by the end of the project, the first year rate might have been 80 percent while the second year rate went to 120 percent.

It can also happen that a large amount of the budget is hurriedly spent as the end of the year approaches because of a rush to spend the remaining allocation and achieve an execution rate close to 100 percent, rather than to make actual careful progress in the project. In such a case, the nominal value of the execution rate—for example, 100 percent—will not reveal the inefficiencies that actually occurred during the year.

There are other limitations that qualify our analysis. The budget execution analysis presented in the study included only 65 countries from the BOOST database. As discussed in the preceding chapter, the BOOST database suffers from problems related to non-random missing values and selection bias. These issues may result in some measurement errors that can make the data less reliable. Subsequently, because of such errors, certain regions or country income groups may be underrepresented, which would restrict the possibility of generalizing the study's conclusions beyond the countries in the study sample.

Additionally, the methodology used for OLS regression to determine the factors affecting budget execution rates is not without its econometric issues. A main one is endogeneity, which means that both the budget execution rate and the economic and political factors being studied can be influenced by some other common underlying but unobserved factors—some third factor. This, when present, creates a bias in the estimation of the coefficients and the interpretation of the significance of the variables in the regression model. One way to address the endogeneity problem is to use instrumental variables that are exogenous to help correct for the potential bias in the estimates.

The findings in this chapter reveal that poor budget execution rates are a key contributor to the substantial spending gaps needed to meet SDG targets 6.1 and 6.2. Thus, developing countries with poor water sector budget execution rates should prioritize improving the sector's absorptive capacity by reducing bottlenecks that can cause implementation delays. Such improvements might include resolving the disconnectedness and fragmentation among the national agencies in charge of the water sector, developing a nationally coherent water policy, utilizing human capital effectively, and ensuring accountability in the budgetary system.

Additionally, improving a country's institutional and political environment is essential in raising budget execution rates. Good project planning and the quality of policies and institutions matter greatly for project outcomes (Denizer, Kaufmann, and Kraay 2013; Isham and Kaufmann 1999). Countries with better public investment management (PIM) and budget transparency tend to have more success in implementing projects on time and within budget (IMF 2018). For example, regular monitoring could provide a more accurate assessment of the budget implementation process. This involves tracking and evaluating the progress of a public sector project at regular intervals to identify and anticipate potential issues ahead of time and take corrective mid-course actions promptly before major problems arise.

Finally, it should be mentioned that broad, vision-driven national support, and the leadership of local authorities, are often important additional elements for project success and scaling-up of investments (Bourguignon and Sundberg 2007; Edwards 2015). Creating country ownership by involving a broad range of stakeholders in the budget process, including civil society organizations and local communities, is also essential because it deepens trust, improves transparency, generates accountability, strengthens state legitimacy, and improves the sense of collective responsibility.

Notes

1. Budget deviation is the difference between the eventual budget execution and the originally approved budget in percentage terms. In the example of the spending shortfall, the budget deviation is 15 percent of the original budget.
2. The number of countries in the study sample is lower than in the preceding chapter because some countries in the BOOST database do not have data on approved spending. For individual sectors, the number of countries included varies: Human Development = 65; Infrastructure = 65; Energy = 64; Transport = 64; Agriculture = 64; Water = 62; WSS = 61; Water Transport = 49; and Irrigation = 34.
3. For example, in Romania's case, the over-the-budget spending in the water sector between 2009 and 2020 can perhaps be explained by the country's extensive investment program to fulfil its compliance with European Union drinking water quality and environmental standards after joining the EU in 2007. The main source of funding for WSS infrastructure in Romania over the last several decades has been grant funding from the EU. This may have not been accounted for in the initial budget allocation.
4. These 46 countries include four non-BOOST countries with less granularity: India, Türkiye, Russia, and Panama. Because of the limited data coverage, regional charts do not include the EAP and MENA regions.
5. The irrigation sector had an over-execution in 2019, which is typical of the subsector, leading to a large percentage difference from 2020. However, even compared to average historical execution rates, the difference is still significant.
6. These included variables are the log of GDP per capita, log of terms of trade, log of debt service per capita, government debt, fiscal balance, urbanization rate, log of population density, government effectiveness, religious fractionalization index, state legitimacy, fragile, conflict-affected, and vulnerable status, and quality of political institutions.
7. On this, see also an interview that Oxford professor Bent Flyvberg gave in *The Washington Post* (Lori Aratani, "Most infrastructure projects are late, over budget. He hopes to fix that," *The Washington Post*, April 28, 2023, updated June 24, 2023, https://www.washingtonpost.com/transportation/2023/04/28/infrastructure-projects-time-budget).

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CHAPTER 3.3

Leaky Faucets, Empty Wallets

KEY MESSAGES

- Both the productivity and the efficiency of public spending in the water sector urgently need to improve as the world moves toward fulfilling the more ambitious targets envisioned in the Sustainable Development Goals (SDGs), with limited resources.
- During the 2009–20 period, the total factor productivity (TFP) of public spending on basic access to Water Supply, Sanitation and Hygiene (WASH) declined by about 6 percent. East Asia and Pacific (EAP) experienced the largest decline, about 12 percent. There is substantial heterogeneity (variability) in TFP across countries in the public spending for the provision of basic WASH services.
- During the 2009–20 period, the TFP of public spending on access to higher-level WASH services such as piped water and sewage connections declined by about 5 percent. The largest decline (8 percent) again occurred in EAP. As with basic services, there is substantial variation in the TFP of public spending to provide higher-level WASH services.
- A decline in average total factor productivity was driven primarily by a 20 percent decline in efficiency in the provision of both basic WASH services and higher-level safely managed WASH services, despite an increase in technological change (TECCH) in nearly all countries during this period. This implies that there is substantial room to improve efficiency in public spending in providing basic and higher-level access.
- Data on 1,599 water utilities from 68 countries over 14 years (2004–17) show that median technical efficiency and cost efficiency were 63 percent and 86 percent, respectively, indicating that there is room for improvement in both.
- The inefficiencies of water utilities are a hidden cost to the economy: For 1,557 water utilities across 67 countries, the average efficiency loss for the period 2004–17 was approximately $21.4 million per utility in 2015 prices, which constitutes about 16 percent of the annual average operating cost of these utilities.
- A more robust regulatory environment increases both technical and cost efficiency, while greater design capacity improves technical efficiency.

Introduction

Public spending is often characterized as less productive and less efficient than private sector investment and has been subjected to intense scrutiny in a world where limited fiscal resources must meet competing needs. Enhancing the productivity and efficiency of public spending is therefore a goal policymaker deeply desire to attain. A majority of countries currently face fiscal challenges stemming from a range of global crises, including the COVID-19 pandemic and its aftermath, the Ukraine War, inflationary pressures, and the increasing incidence of climate-driven natural disasters. Getting a bigger "bang for the buck" from available fiscal resources has therefore become a priority because to achieve the water sector's SDG targets, that is, providing universal coverage for higher-level services such as safely managed WASH will cost significantly more than basic-level services (see part 2 chapter 2). Finding ways to increase efficiency in providing water supply and sanitation (WSS) services would therefore go a long way to assist the sector in achieving its targets.

Let's See... .Is That Productivity, or Efficiency?

Productivity measures the amount of output a worker, system, or economy can achieve in a certain amount of time, regardless of how much resources need to be employed to achieve that output. Productivity is raw performance. **Efficiency,** though, measures how economically—or put another way, how frugally—that same worker, system, or economy uses those resources to achieve a certain level of output. Productivity is doing more in less time. Efficiency is doing more with fewer resources.

Production possibility frontier is a concept used to define the maximum level of output an economy can attain with given inputs. Productivity is commonly measured as total factor productivity (TFP), which captures changes in output that cannot be simply explained by the changes in inputs. By contrast, efficiency is a measure of how close a firm's operations can approach its production possibilities frontier, with the minimum use of inputs. Spending is efficient when it attains the intended objectives (that is, the maximum production of outputs) at the lowest possible cost (that is, the least use of inputs).

It is true that for a given level of resource inputs, a more *efficient* process will also be more *productive*, and in that sense, productivity and efficiency seem related. But in economics, the two are quite distinct concepts. (box 3.3.1). Efficiency is a measure of how well—that is, how economically or frugally—an economy uses its resources to achieve a certain level of output, whereas productivity measures the amount of output the economy can achieve, regardless of the resources it must use to achieve that output. In other words, efficiency is the use of available resources in the most cost-effective way, whereas high productivity can be relatively inefficient.

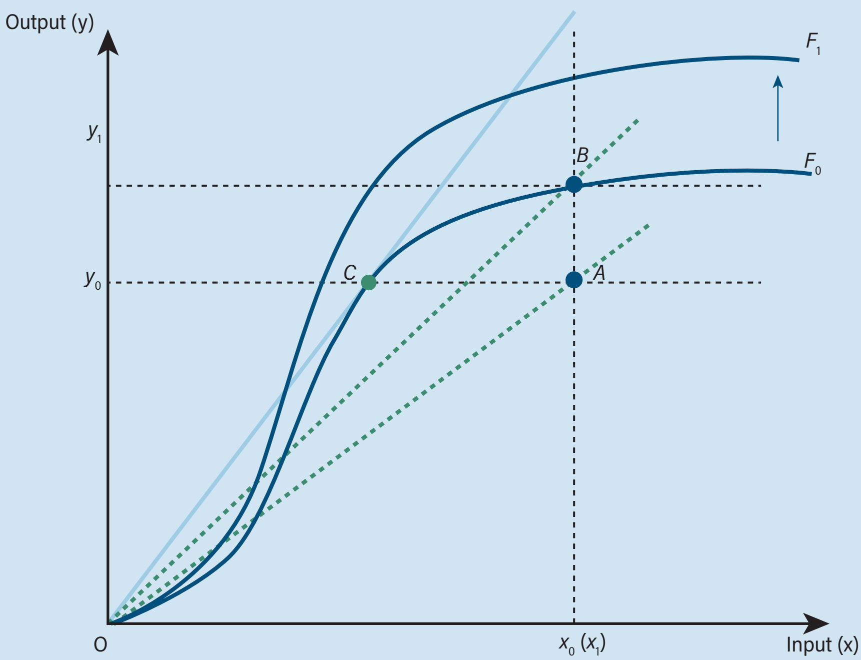
In an ideal world, perfectly competitive markets both promote efficiency in the use of resources *and* tend to generate high productivity. The other extreme is also true. Dysfunctional, uncompetitive markets are often characterized by both low efficiency and low productivity. In the real world, governments may intervene to

BOX 3.3.1 Measuring Productivity and Efficiency

To better understand the difference between productivity and efficiency, consider a simple production process that uses a single input, x, to produce a single output, y. In figure B3.3.1.1, the line OF represents the production possibility frontier, which defines the relationship between input and output given the current state of technology in the industry. As you can see, there are actually two versions of the line, OF_0 and OF_1, but we will come to that in a moment. Points A, B, and C represent different levels of technical efficiency in a firm. Firms operating on the production frontier (that is, on the line) are considered technically efficient, while those operating beneath the frontier (under the line) are considered technically less efficient. Both points B and C are considered efficient, but only C is the point of optimal scale and maximum possible productivity.

Measuring productivity at a particular data point involves drawing a ray from the origin to that point, with slope y/x. Moving from an inefficient point (for example, point A) to an efficient point (for example, point B) raises productivity, but exploiting economies of scale by moving to the point of optimal scale (for example, point C) can further improve productivity. What this demonstrates is that although a firm may be technically efficient (point B), it may still have room for improvement in productivity by taking advantage of economies of scale (point C).

FIGURE B3.3.1.1 Productivity, Technical Efficiency, and Economies of Scale



Note: Authors' illustration.

In economics, assessing productivity over time requires examining a range of factors that contribute to changes in output relative to input. In addition to efficiency improvements, technical change can play a significant role. Technical change refers to advances in technology—sometimes paradigm-shifting—that "change the entire game" in that they have the potential to revolutionize production processes, often

box continues next page

BOX 3.3.1 Measuring Productivity and Efficiency (*Continued*)

leading to the entire production frontier line shifting upward.

This is depicted in figure B3.3.1.1 by the movement of the production frontier from period 0 (the old period), represented by line OF_0, to period 1 (a new moment in history), represented by line OF_1. In period 1, all firms can now produce more output for a given level of input than what was possible in period 0.

In other words, technology change has made them more efficient. Think of locomotive transport versus ox cart. Examples of technical progress include the automation of production lines in a factory, the implementation of new warehouse systems to improve supply chain logistics, or research and development (R&D) that creates new drugs that make people (including workers) healthier. Such innovations often require significant investment in R&D and capital, including human capital, which can result in long-term benefits for both firms and economies.

In summary, when a firm increases its productivity, this may not necessarily be due to efficiency gains alone. Instead, it may result from technical progress, the exploitation of scale economies, or a combination. Thus, it is essential to consider the various sources of productivity change when examining a firm's performance over time. Details are provided in appendix C.

overcome market failures or to achieve certain desired social goals as discussed in earlier chapters. This is particularly true of the water sector because of its unique characteristics.

In the context of raising the productivity and efficiency of public spending in the WSS subsector, the critical questions that repeatedly come up concern (i) whether with the current level of spending, the sector can provide more WSS services, and (ii) whether improvement in the coverage of WSS services is achieved using the least possible cost (highest efficiency). During the last decade, many countries met the MDG goal of universal access to improved drinking water and sanitation. But now that the world is moving toward achieving the more ambitious targets envisioned in SDG targets 6.1 and 6.2, there is a pressing need to improve the input efficiency of meeting this goal by further minimizing the cost-of-service provision. Ultimately, the cost will depend on several factors, including the type of technology used, how closely customers live next to one another—efficiently compact urban design versus urban sprawl, for example—and whether the widespread adoption of services by customers leads to greater economies of scale.

This chapter examines the productivity and efficiency of spending in the WSS sector from two perspectives. First, it explores whether, at the country level, for a given level of public spending, there is room to achieve more access to WSS services. Second, using International Benchmarking Network (IBNET) data, it examines the performance of water utilities to determine if there is also more room for efficiency improvements, meaning the same level of access can be achieved with fewer inputs or at lower cost.

Measuring Public Spending Productivity and Efficiency in WSS

The analysis in this section aims to estimate the change in TFP in the WSS sector among 58 countries during the years 2009 to 2020, using the Data Envelopment Analysis (DEA)-based Malmquist Productivity Index (MPI). DEA can measure the extent to which the WSS sector in each country deviates from the efficiency frontier. The MPI also helps to decompose the change in TFP[1] across two time periods—into technological change (TECCH)[2] and efficiency change (EC).[3] EC can be further decomposed into scale and pure EC.[4] MPI can therefore also illustrate the relative contributions of technological change and efficiency change to TFP.

INPUTS AND OUTPUTS OF WSS

The analysis below tries to understand whether changes in access to WSS services from 2009 to 2020 were achieved by the efficient utilization of public resources, and whether greater access might have been possible with a given level of spending. The main outputs therefore are the levels of access to WSS services of various kinds on a national scale over a given period. The primary input is capital expenditure and operational expenditures by the government in each country to achieve WSS access over the same period. From the perspective of production, a country can be thought of as a firm that produces outputs (access to WSS services, in this case) using inputs (capital and operational and maintenance expenditures, in this case). Different levels of service—for example, a basic level of services versus piped water and sewerage connections—have different infrastructure requirements, such as pipe networks and treatment plants. So two sets of service level and output variables are under consideration: access rates to basic water and sanitation, and second, access rates to piped water and sewerage connections.[5] (Because of data limitations, however, it was not possible to distinguish public spending in water by service level and type.)

To account for differences in population among countries and across time, per capita expenditure (CAPEX) and per capita operating expenditure (OPEX), both measured in US dollars ($), are used as input variables, each of which is calculated by dividing total capital and operational expenditures by population. Total public sector expenditure figures from national budget data are available from the BOOST database. Using per capita CAPEX and per capita OPEX as two separate variables also allows the analysis to reflect the possible tradeoffs between these costs (Jamasb, Nillesen, and Pollitt 2004). This is because OPEX, in the form of water maintenance, is needed to preserve infrastructure assets and reduce the need for future CAPEX in reconstruction. At the same time, the need to respect maintenance norms on existing assets limits the resources available for further expansion and upgrading of the water network. The data on output variables—access levels for primary and higher-level WSS services—are obtained from the WHO/UNICEF Joint Monitoring Programme (JMP).

Both the output and input variables included in this analysis have large variations across countries because of country-specific factors such as wages and infrastructure costs. For example, Armenia and Costa Rica have similar average rates of access to piped water, around 96–97 percent,[6] yet the mean decadal average CAPEX per capita and decadal average OPEX per capita for Armenia are $8.40 and $5.80, respectively, but $15.90 and $44.20 for Costa Rica. In contrast, over the last decade, Haiti and Kenya have had 30–32 percent piped water coverage, but CAPEX per capita and OPEX per capita for Haiti were just $0.41 and $0.70, compared to $3.60 and $0.70 or Kenya.

PRODUCTIVITY AND EFFICIENCY

This analysis adopts the input-oriented, non-parametric Data Envelopment Model, which minimizes inputs while holding outputs at their current level and estimates MPI. MPI measures productivity changes over time, which can be decomposed into changes in efficiency and technology. Total factor productivity change (TFPCH) is computed as the geometric mean of MPI between two time periods, t and $t + 1$, which can be decomposed into TECCH and EC. The latter can be further decomposed into pure efficiency change (PECH) and scale efficiency change (SECH). TFPCH greater than 1 indicates growth in productivity between periods t and $t + 1$, whereas a value less than 1 indicates a decline in productivity. A value of 1 denotes stagnation in productivity.[7]

The estimates of MPI and decomposition are reported in table 3.3.1. Regarding improving access to basic water and sanitation services, the analysis indicates that between 2009 and 2020, there was on average a deterioration of 6 percent (geometric mean of 0.864 for all countries) in TFP in the study sample. This was attributable mainly to efficiency losses, even though there was an improvement in technology during the period. Further decomposition of EC shows that the technical efficiency loss was attributable mainly to scale effects and pure EC.

TABLE 3.3.1 Malmquist Productivity Index of Producing Basic-Level Service, Presented as the Geometric Mean of Regions and All Available Countries

	Total factor productivity change (TFPCH)	Technological change (TECCH)	Efficiency change (EC)	Efficiency change (EC)	
				Scale efficiency change (SECH)	Pure efficiency change (PECH)
Panel a: MIndex (MPI)					
East Asia and Pacific	0.760	1.650	0.460	0.847	0.544
Europe and Central Asia	0.862	1.325	0.650	0.748	0.869
Latin America and the Caribbean	0.860	1.306	0.658	0.824	0.799
Middle East and North Africa	0.967	1.350	0.710	0.812	0.874

table continues next page

TABLE 3.3.1 Malmquist Productivity Index of Producing Basic-Level Service, Presented as the Geometric Mean of Regions and All Available Countries (*Continued*)

	Total factor productivity change (TFPCH)	Technological change (TECCH)	Efficiency change (EC)	Efficiency change (EC)	
				Scale efficiency change (SECH)	Pure efficiency change (PECH)
South Asia	0.901	1.267	0.711	0.978	0.727
Sub-Saharan Africa	0.847	1.309	0.647	0.960	0.674
All Available Countries	0.864	1.362	0.633	0.858	0.738
Panel b: log-linearization (%)					
East Asia and Pacific	−0.12	0.22	−0.34	−0.07	−0.26
Europe and Central Asia	−0.06	0.12	−0.19	−0.13	−0.06
Latin America and the Caribbean	−0.07	0.12	−0.18	−0.08	−0.10
Middle East and North Africa	−0.01	0.13	−0.15	−0.09	−0.06
South Asia	−0.05	0.10	−0.15	−0.01	−0.14
Sub-Saharan Africa	−0.07	0.12	−0.19	−0.02	−0.17
All Available Countries	−0.06	0.13	−0.20	−0.07	−0.13

Source: Authors' calculation based on BOOST and Joint Monitoring Programme (JMP) data. Panel a of this table presents the geometric means for the input-oriented Malmquist index and its components for the period 2009–2020, assuming neutral technical change. Panel b takes a log-linearized form of Panel a, which can be interpreted as percentage changes.

Basic services. The trends in the TFP of basic water and sanitation services across regions from 2009 to 2020 reveal similar patterns. Despite the significant technological progress, especially in the East Asia and Pacific region, there was a noticeable decline in TFP due to a sharp decline in efficiency. As depicted in the table, improving efficiency is the primary driver that pushes the production productivity frontier. However, some regions, such as Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), and the Middle East and North Africa (MENA), have experienced a relatively more significant loss in scale efficiency primarily due to near-full coverage of basic services. These regions do not possess the ability to further expand access and gain from the scale efficiency coming from increased provision. Nevertheless, there is still significant potential to increase pure efficiency across all regions by allocating resources more appropriately and enhancing the quality of management and other inputs.

Higher-level services. Like basic access, for higher-level services such as piped water access and sewer network access, there was a decline in TFP of about 5 percent. The TFPCH index of producing higher-level service presented in table 3.3.2 is 0.890. Across all regions, there has been an impressive advancement in technology but a decline in pure and scale efficiency. This decline, however, also led to a decrease in the TFP of higher-level services from 2009 to 2020. Specifically, the East Asia and Pacific (EAP) region's decline in TFPCH was primarily driven by the decrease in pure efficiency despite technological improvements. Comparing tables 3.3.1 and 3.3.2, it is evident that the decline in TFP for piped water and sewer access is slightly lower than that of producing basic-level service, but the efficiency is comparatively smaller. This observation indicates that there is relatively more room to enhance efficiency in producing higher-level services. Moreover, although the scale effects are consistent across both levels of service production, higher-level service has a slightly smaller PECH across all regions. Thus, to expand the frontier and produce higher-level services, the key is to generate efficiency gains while maintaining progress in technology.

TABLE 3.3.2 Malmquist Index of Producing Higher-Level Services, Presented by the Geometric Mean of Regions and All Available Countries

	Total Factor Productivity Change (TFPCH)	Technological Change (TECCH)	Technical Efficiency Change (EC)	Technical Efficiency Change (EC)	
				Scale Efficiency Change (SECH)	Pure Efficiency Change (PECH)
Panel a: Malmquist productivity index (MPI)					
East Asia and Pacific	0.841	1.626	0.517	0.986	0.525
Europe and Central Asia	0.857	1.385	0.619	0.786	0.787
Latin America and the Caribbean	0.893	1.354	0.660	0.868	0.760
Middle East and North Africa	0.969	1.415	0.685	0.955	0.718
South Asia	0.933	1.386	0.673	0.995	0.677
Sub-Saharan Africa	0.853	1.349	0.632	0.944	0.670
All Available Countries	0.890	1.416	0.628	0.919	0.684
Panel b: log-linearization (%)					
East Asia and Pacific	−0.08	0.21	−0.29	−0.01	−0.28
Europe and Central Asia	−0.07	0.14	−0.21	−0.10	−0.10
Latin America and the Caribbean	−0.05	0.13	−0.18	−0.06	−.12
Middle East and North Africa	−0.01	0.15	−0.16	−0.02	−0.14
South Asia	−0.03	0.14	−0.17	0.00	−0.17
Sub-Saharan Africa	−0.07	0.13	−0.20	−0.02	−0.17
All Available Countries	−0.05	0.15	−0.20	−0.04	−0.17

Source: Authors' calculation based on BOOST and JMP data. Panel a of this table presents the geometric means for the input-oriented Malmquist index and its components for the period 2009–20, assuming neutral technical change. Panel b takes a log-linearized form of Panel a, which can be interpreted as a percentage change.

COUNTRY-LEVEL MALMQUIST INDEX

Shifting the focus to productivity and efficiency in WSS service provision in individual countries reveals considerable heterogeneity.[8] Figure 3.3.3 (panel a) presents the log-linearized decompositions of TFP into TECCH and EC. The distance between each dot and the origin represents a percentage change, with positive changes indicated by changes to the right and negative changes by changes to the left. After ranking countries based on EC (dark blue dots) within each region, it was found that the changes in TFP (green dots) over time were offset by the negative ECs over the years. The same technique also applies to the decomposition of EC into SECH and PECH, as shown in figure 3.3.3 (panel b), also ranked on EC within regions. The change in efficiency (dark blue dots) is driven by changes in scale efficiency, represented by green dots, and by pure efficiency, represented by red dots.

It is not surprising that WSS TFP decreased by around 6 percent on average for most countries, as shown in table 3.3.1. However, despite the progress made in technology, the losses in pure efficiency and scale efficiency observed in most countries have impacted the TFP of basic water and sanitation services. Notably, a few countries—Ethiopia with a 5 percent increase, Namibia with 2 percent, Fiji with 5 percent, and Indonesia with 9 percent—stand out for managing positive changes in TFPCH. This positive shift can be attributed to substantial technological improvements that have managed to counterbalance the efficiency losses experienced in these nations.

It is also noteworthy that all the countries have experienced pure efficiency losses to some extent, indicating that there is room for improvement in the use of resources and management practices to enhance the efficiency of public spending in the sector. Meanwhile, only a few countries have demonstrated a positive scale EC, suggesting that economies of scale have yet to be fully realized in most countries.

In the production of higher-level service, the sample countries again saw a 5 percent decline in TFP on average. Figure 3.3.4 shows substantial dispersion (variation) in efficiency performance by country. Only a few countries performed better in terms of TFPCH: Ethiopia with an increase of 5 percent, Mozambique with 5 percent, Indonesia with 8 percent, Guatemala with 5 percent, and a few others with around 1 percent. However, it is important to note that these countries were the exception; most countries did not see any productivity gains. Moreover, none of the sample countries achieved efficiency gains, and most of the efficiency losses were driven by a decrease in pure efficiency.

This finding underscores the need to prioritize measures that can enhance pure efficiency, such as improving management and operational practices, optimizing the use of resources, and enhancing mechanisms of service delivery. Additionally, policymakers should pay close attention to the factors that contribute to efficiency loss and develop targeted interventions to address them.

FIGURE 3.3.3 Country-Level Malmquist Index of Access to Basic-Level WSS Services

a. Technical Change, Scale Change, and Pure Efficiency Change

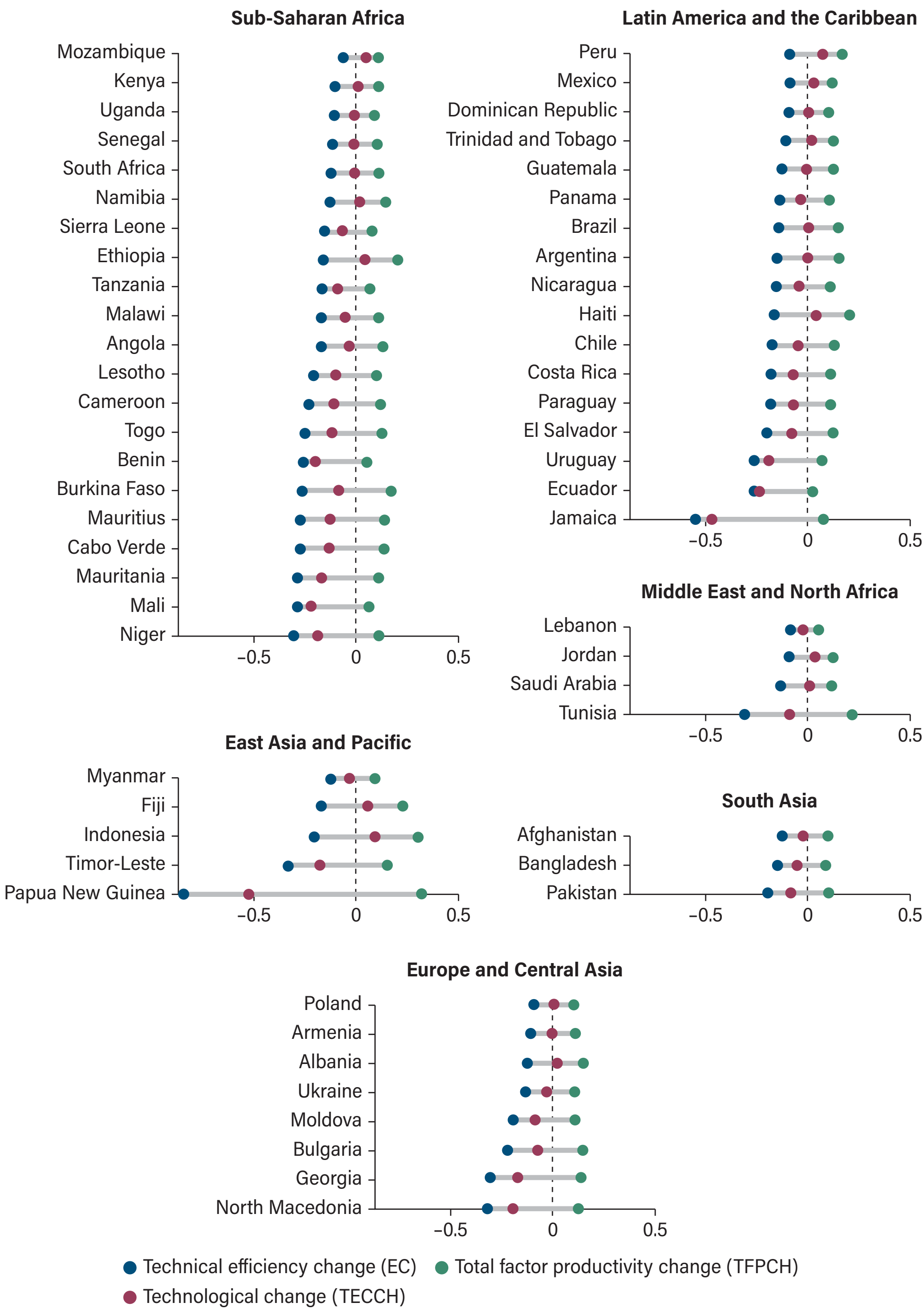


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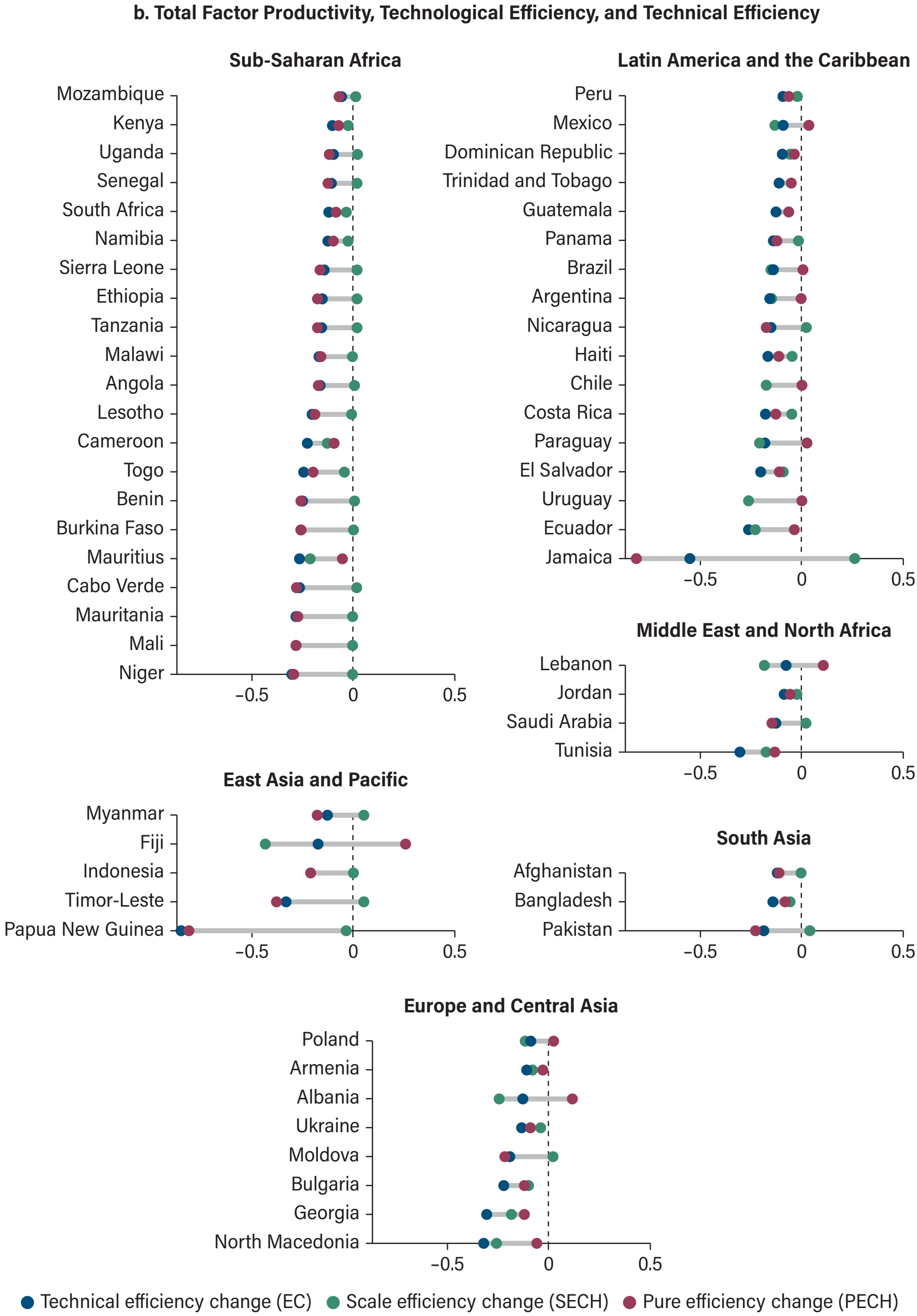
FIGURE 3.3.3 Country-Level Malmquist Index of Access to Basic-Level WSS Services (*Continued*)



Source: Authors' estimation using BOOST and JMP databases

FIGURE 3.3.4 **Country-Level Malmquist Index of Access to Higher-Level WSS Services**

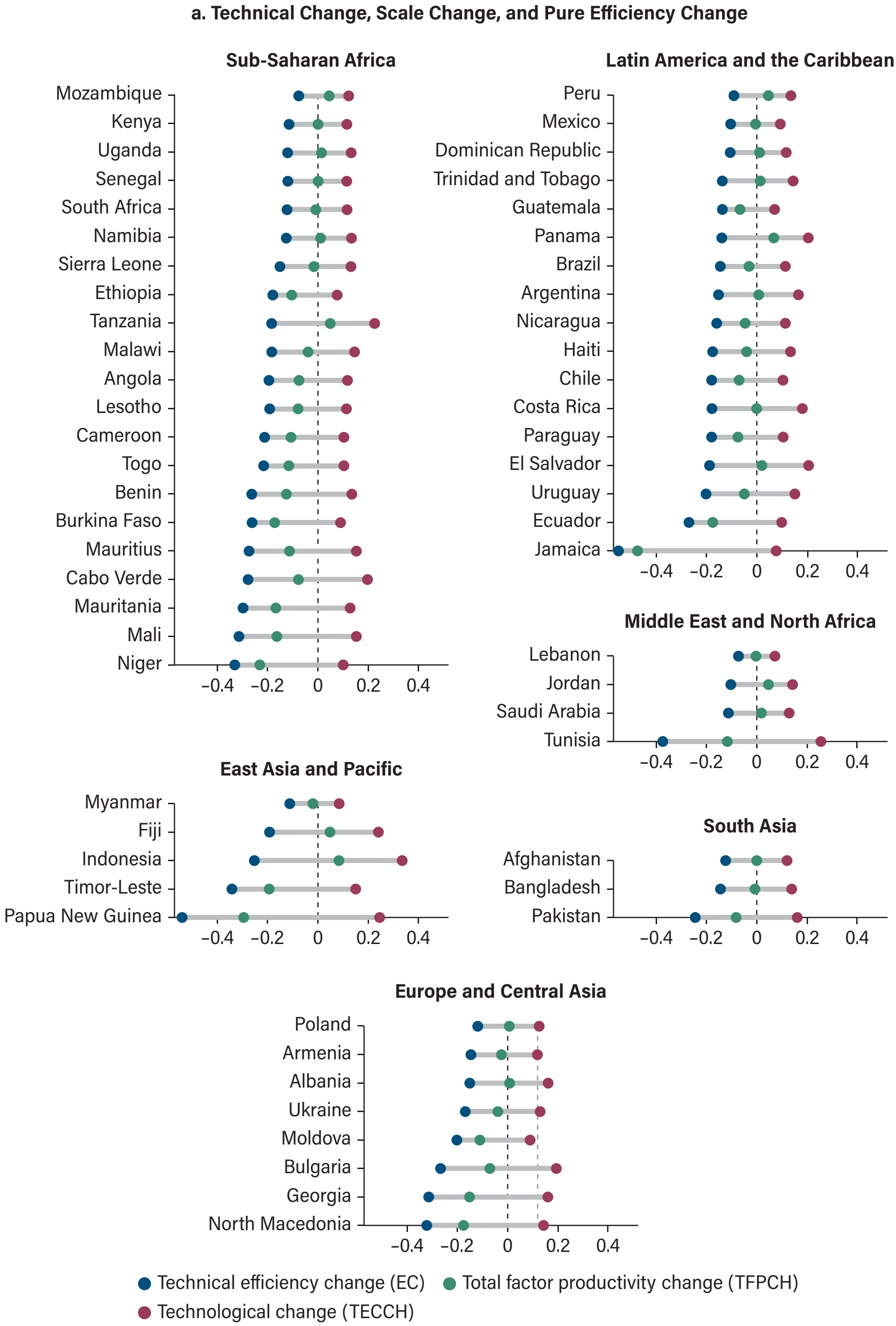


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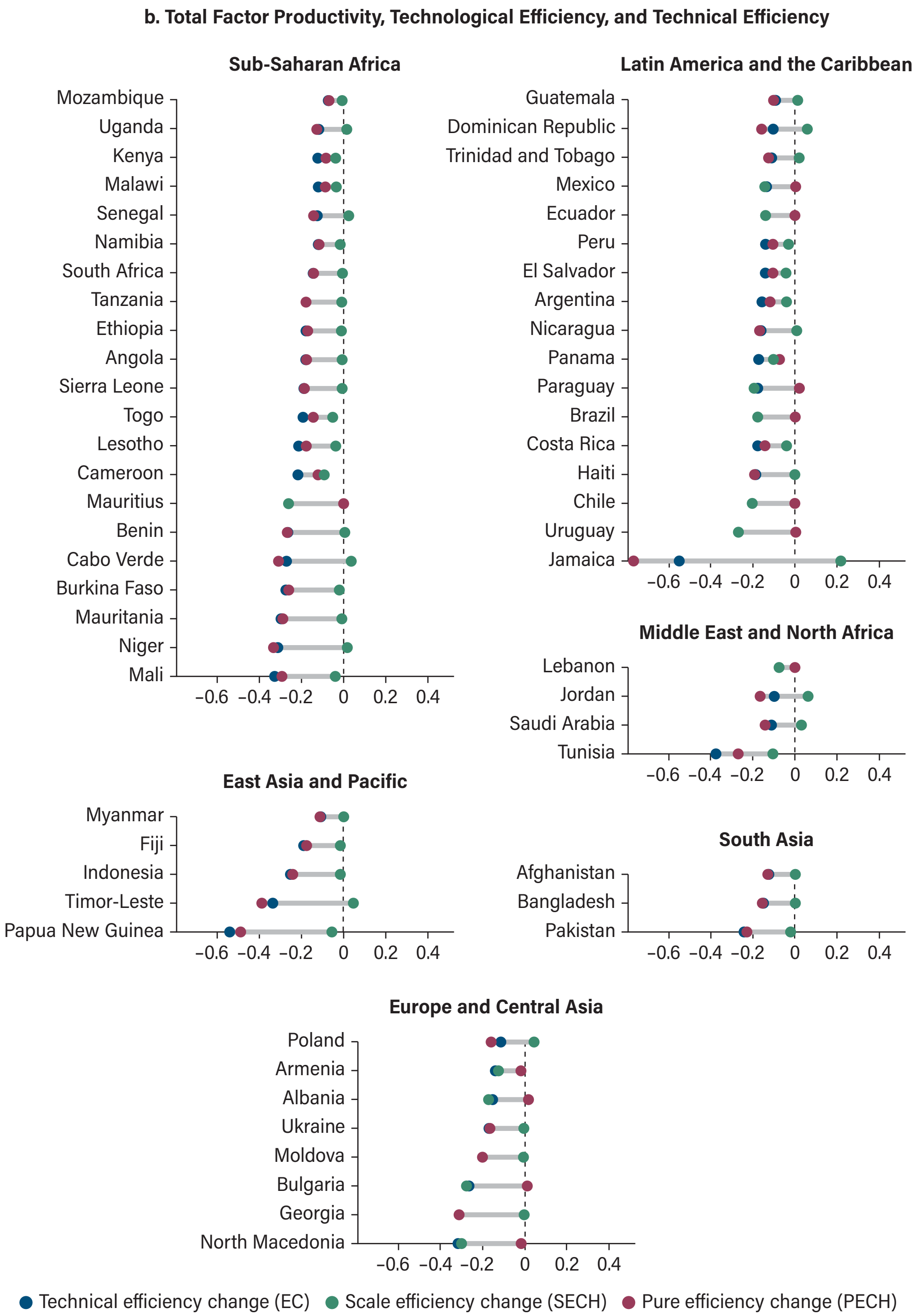
FIGURE 3.3.4 **Country-Level Malmquist Index of Access to Higher-Level WSS Services (*Continued*)**

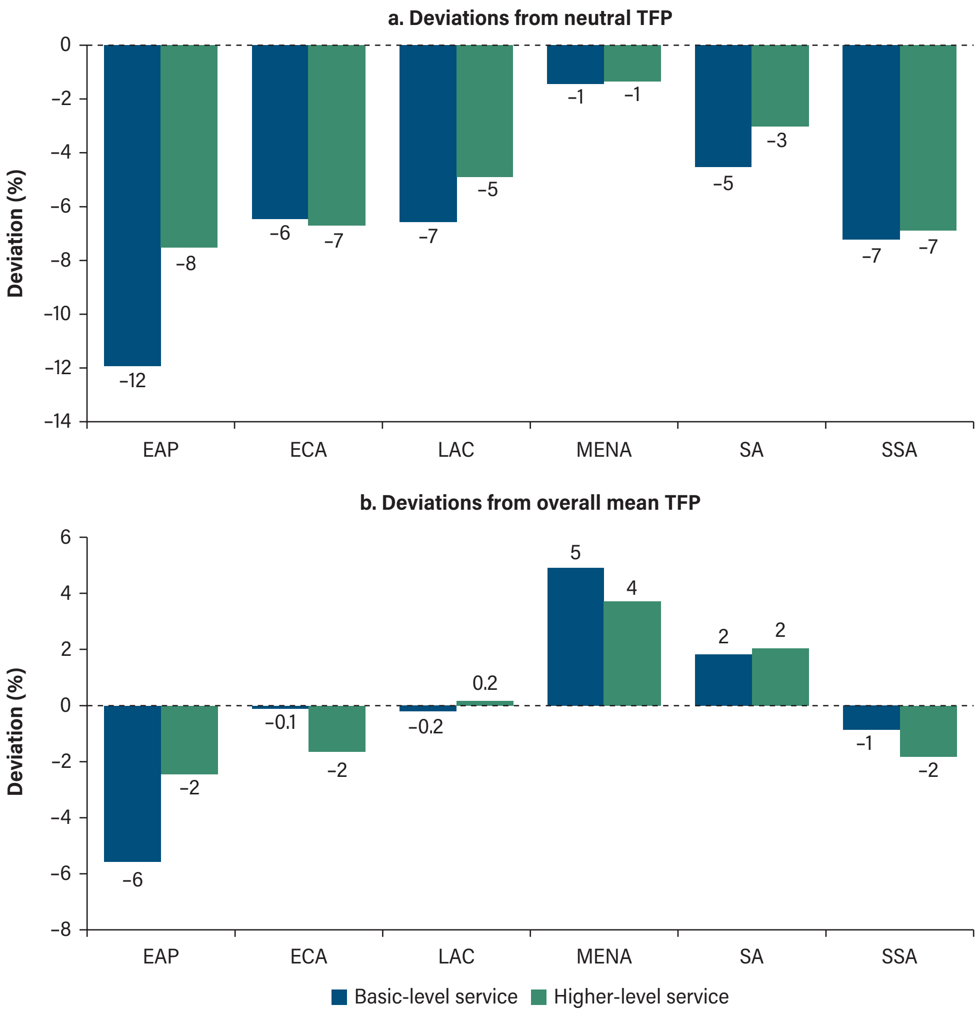


Source: Authors' estimation using BOOST and JMP databases

WHO PERFORMED RELATIVELY BETTER?

As stated earlier, countries in the study sample exhibited a decline in TFP in delivering basic-level and high-level services of 6 percent and 5 percent, respectively. Figure 3.3.5 presents two sets of comparisons of TFP—from the benchmark of 1, which indicates stagnant growth, and from the overall sample mean, at the regional level. For the production of basic access, for example, EAP is 12 percent below the stagnation benchmark and 6 percent lower than the overall mean of the sample. For the production of higher-level services, EAP is 8 percent below stagnation levels and 2 percent behind the overall mean of the sample.

FIGURE 3.3.5 Deviations from Total Factor Productivity, by Region



Source: Authors' calculation based on BOOST and JMP data
Note: Panel a, left, shows deviations from for regional means from neutral TFP; panel b, right, shows deviations of regional means from the overall mean (*N* = 58). See appendix E for the detailed table. EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa; TFP = Total factor productivity.

Measuring the Efficiency of Water Utilities

Efficiency—the production of an output using the optimal (that is, least costly) combination of inputs—can be examined from two related perspectives: technical efficiency and cost efficiency.

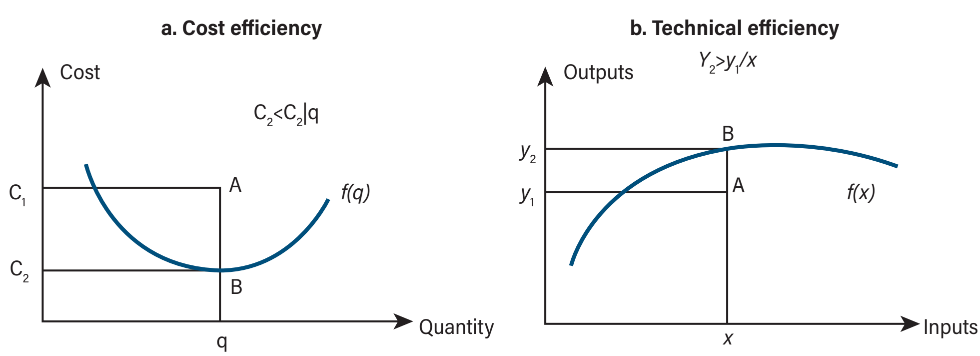
Next, the analysis uses utility-level data to examine the efficiency of water utilities in providing drinking water and, in many cases, sanitation services. All over the world, a vast majority of safely managed WSS services are provided by utilities owned by the national and subnational governments, state-owned enterprises, and the private sector. Many such utilities experience significant gaps in covering their cost-of-service provisions. For instance, Andrés et al. (2020) found that only 35 percent of the utilities in the IBNET database can cover their operations and maintenance (O&M) costs of service provision, and 14 percent of all utilities can cover the total cost, that is, O&M and capital costs.

In light of this, this section delves further into the discussion about water sector efficiency by focusing on the water utilities' technical and cost efficiencies in order to evaluate the extent of the inefficiencies they face and the opportunities for improvement. The section also explores whether certain country-level features tend to affect the efficiency of utilities in the long run.

Efficiency—the production of an output using the optimal (that is, least costly) combination of inputs—can be examined from two related perspectives: technical efficiency and cost efficiency. Recall from the definition of efficiency offered earlier, in the introduction of this chapter, that a production plan adopted by a firm or utility is considered technically inefficient if a higher level of output is technically attainable from a given set or combination of inputs (output-oriented measure), or if the observed output level can be produced using fewer inputs (input-oriented measure) (Kumbhakar, Wang, and Horncastle 2015). Similarly, cost efficiency refers to a firm's ability to produce a certain level of output at the lowest possible cost, given the available inputs and their prices.

Figure 3.3.6 provides a simple illustration of cost efficiency and technical efficiency using one input and one output. f(q) and f(x) represent various levels of cost (outputs) for each level of quantity (inputs), respectively.

FIGURE 3.3.6 Cost Efficiency and Technical Efficiency in a One-Input, One-Output Case



Note: Authors' illustration.

A Stochastic Frontier Analysis (SFA) for panel data was used to estimate the relative efficiency of utilities over time and across countries. The SFA employs a parametric approach (statistical models) to estimate the production frontier and cost frontier, and the technical and cost (in)efficiencies with respect to these frontiers. The main advantage of a Stochastic Frontier (SF) approach is its ability to tease out the error term from the inefficiency.[9] The World Bank IBNET data contain information about inputs, outputs, and performance indicators for 5,191 utilities from 151 countries for the period 1994–2020. Because of concerns about the accuracy and reliability of data from the earlier and most recent years, and missing values, the final sample was restricted to 1,599 utilities from 68 countries for the 2004–17 period.[10] The results of the Stochastic Production Function estimations of cost efficiency and technical efficiency are provided in table 3.3.3.[11]

Results from the stochastic frontier estimation show that the median cost efficiency of water utilities from 2004 to 2017 was 86 percent, and the technical efficiency 63 percent. This means that, when compared to the best-performing water utility, which is on the cost frontier, the median water utility has room to reduce its overall cost by 14 percent and yet provide the same level of service. Similarly, the median utility can increase its output by 37 percent (100 minus 63), given the same level of inputs, compared to the best-performing utility on the production frontier.

In short, there is considerable scope for efficiency improvements among water utilities from both the cost and the production perspectives. As the estimations of cost and technical efficiency show, utilities suffer more from technical efficiency losses, for two reasons. First, to estimate technical efficiency, the total value of the water produced is evaluated at average tariffs, which tend to be "sticky" (slow to change) over the medium term. At the same time, the operating costs are more reflective of actual market prices. Second, owing to losses at various stages of production and transmission, the total water produced tends to be more than the total water billed.

Cost and production efficiencies are more responsive (sensitive) to changes in labor than they are to other inputs used in the model. As table 3.3.3 indicates, a $1 increase in labor cost increases overall cost by $0.53 but increases the nominal value of production (total production volume multiplied by average tariff rate) in 2015 dollars by $0.20. In other words, for every dollar spent on labor, cost increases about 2.5 times more than production. This is primarily driven by the fact that tariffs are low and tend to be less flexible relative to labor costs.

Cost and production elasticities of energy used are second only to labor. Table 3.3.3 shows that a $1 rise in energy cost leads to an overall cost increase of $0.12 while also increasing the value of production by $0.04, assuming the tariff remains the same. Cost and value of production, however, are not as responsive to other inputs, such as repair and maintenance, contracted services, or other costs. The respective directions indicated by the positive and negative signs on the coefficients of O&M cost of machinery can be interpreted to mean that better maintenance may improve production but will be less cost-efficient.

Median cost efficiency of water utilities from 2004 to 2017 was 86 percent, and the technical efficiency 63 percent.

TABLE 3.3.3 Stochastic Frontier Regressions for Cost and Technical Efficiency

		(1) Cost frontier	(2) Production frontier
ldc3	Log of electricity/energy cost in international PPP	0.124***	0.044***
ldc4	Log of repair + maintenance cost in 2017 international PPP	0.001	−0.004
ldc5	Log of contracted service cost in 2017 international PPP	0.008**	0.021*
ldc6	Log of Other cost in 2017 international PPP	0.015***	0.042***
ldc9	Log of labor cost in 2017 international PPP	0.527***	0.202***
time	Time in years (2004–17)	−0.003**	−0.048***
Usigma	Variance in inefficiency	−2.254***	−1.734***
Vsigma	Variance of idiosyncratic error	−2.669***	−1.592***
Theta		1.764***	3.243***
Constant		4.993***	10.856***
Observations		22,043	22,043
Number of utilities		1,599	1,599

Source: Authors' estimation using IBNET data.
Note: Dependent variables are the logarithm of total operating cost and logarithm of the value of total production, respectively (total water produced multiplied by the average tariff rate) in US dollars at 2015 prices. PPP = public-private partnerships; (*) = p-value <0.1; (**) =p-value <0.05; *** =(p-value) <0.01

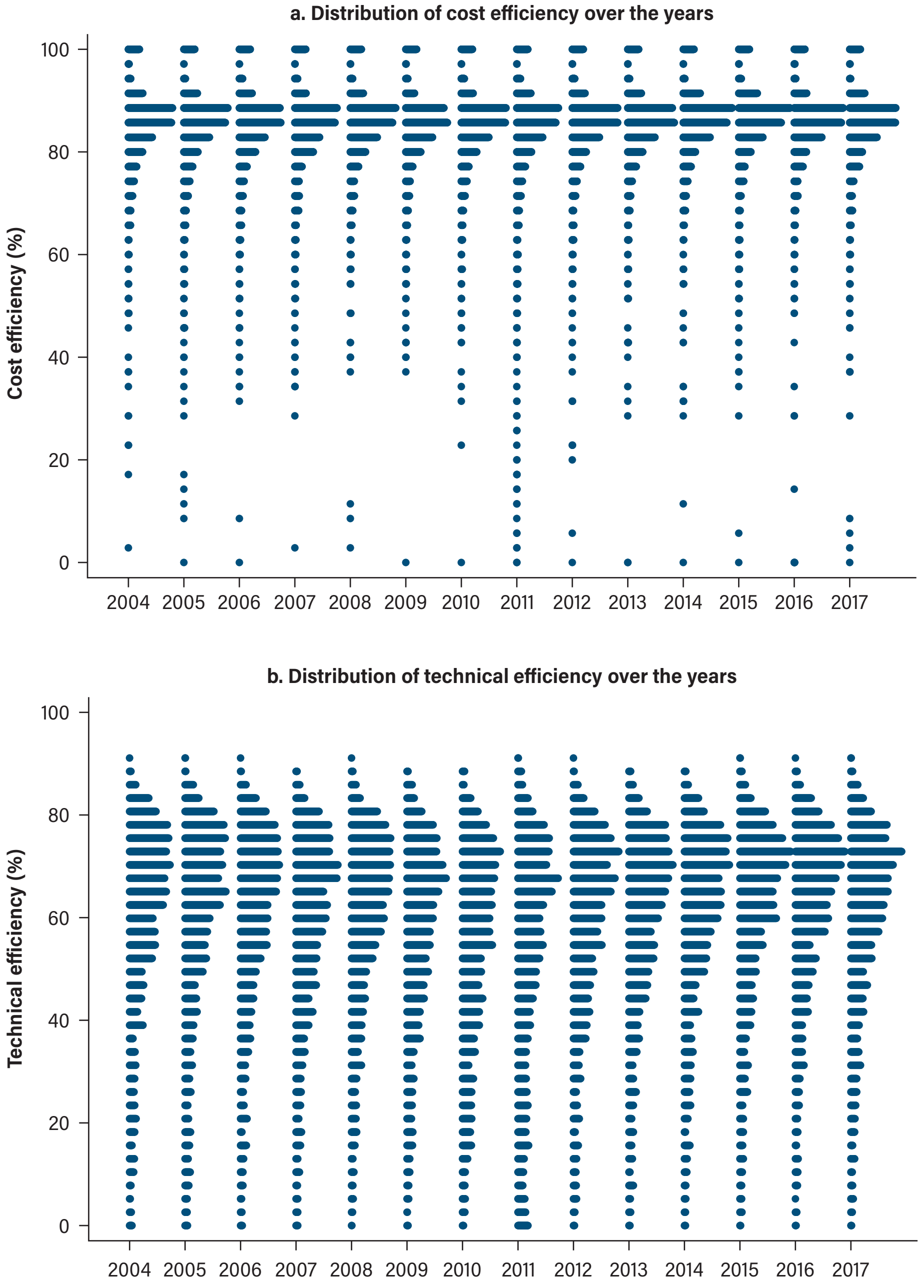
COST AND TECHNICAL EFFICIENCY FURTHER INSIGHTS

In this section, we comprehensively examine the dynamics of cost and technical efficiency, offering insights into their temporal and structural variations. By methodically disaggregating the data annually and further categorizing it by characteristics such as utility size, ownership type, and capital utilization, we aim to provide a granular-level understanding of how these efficiencies manifest across different dimensions.

Figure 3.3.7 presents the annual estimated cost efficiency (left) and technical efficiency (right) of each utility from the preceding frontier analysis in the form of dot plots. It was found that the distribution of cost efficiency is skewed to the right (or bottom as presented here), meaning that the concentration of utilities is much higher at higher levels of efficiency. This pattern is the same for all years between 2004 and 2017.

A similar pattern can be observed for the distribution of technical efficiency scores for all years between 2004 and 2007, although the variability is much more pronounced than for cost efficiency. It is also skewed to the right, meaning that, again, the concentration is much higher at higher levels of efficiency, even though a wider distribution is observed.

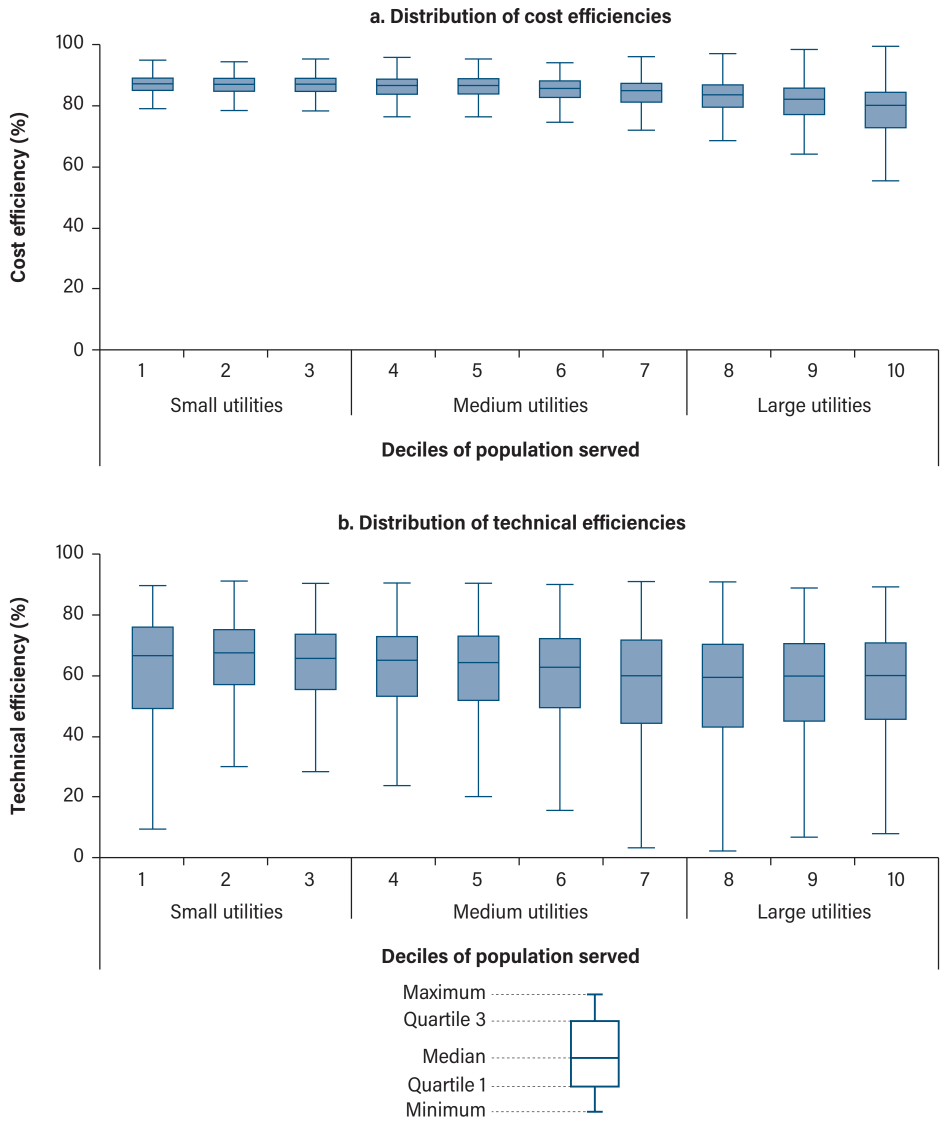
FIGURE 3.3.7 The Distribution of Cost Efficiency and Technical Efficiency of Utilities, 2004–17 (%)



Source: Authors' elaboration using IBNET data.

Cost efficiency and technical efficiency show clear patterns with respect to the size of the utility as measured by the population served.[12] The utilities are grouped into 10 deciles, in ascending order, based on the size of population served by each utility, to create 10 different sizes of utilities across countries. Small utilities are defined as those in the lowest three deciles, deciles 1–3. Medium-sized utilities fall in deciles 4–7, and large in deciles 8–10. In general, smaller utilities are more cost-efficient than larger ones.[13] Figure 3.3.8 (panel a) shows that the smaller the utility, the higher the median cost efficiency, and as size increases, median values gradually decrease.

FIGURE 3.3.8 Median and Distribution of Cost and Technical Efficiencies, by Size of Water Utility



Source: Authors' estimation using IBNET data.

Another important finding from figure 3.3.8[14] (panel a) is that the smaller water utilities have a more compact distribution of cost efficiency than other size groups. It means that more utilities in this group have similar cost efficiency with less variation than can be observed among the larger utilities, where the level of cost efficiency varies more widely as the size of the utility increases.

A similar pattern of an inverse relationship between technical efficiency and utility size is observed in figure 3.3.8, panel b, albeit with a much less pronounced effect than with cost efficiency. Although the median technical efficiency values decrease slightly as utility size increases, the large spread of efficiency between the top and bottom 25 percent of utilities in each decile suggests that the levels of technical efficiency of the mid-size utilities are more similar to each other, with lower variation. For smaller utilities, the distribution of the top 50 percent is more compact than the bottom 50 percent, resulting in a higher median value.

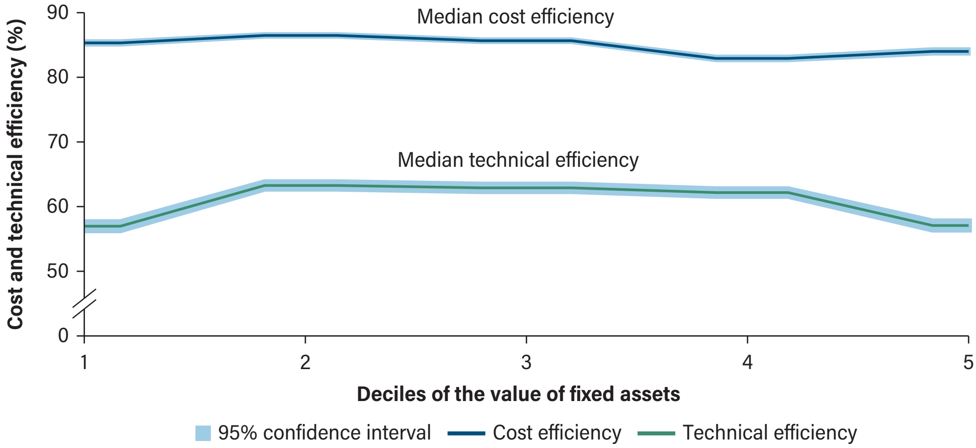
The distribution of cost efficiency is skewed to the right, meaning that the concentration of utilities is much higher at higher levels of efficiency.

One reason for the lower efficiency among smaller utilities could be the suboptimal use of capital as a result of capacity constraints. By contrast, the lower median efficiency of large utilities could be due to the inefficient use of inputs or the overuse of capital. Of note, the analysis finds that the variation in the top or bottom 25 percent of the distribution gradually diminishes as the size approaches mid-size from both the small and the large end.

The relationship between capital utilization and cost and technical efficiency is examined by a kernel-weighted local polynomial smoothing technique, as illustrated in figure 3.3.9. As discussed above, cost efficiency consistently outpaces technical efficiency in all quintiles of fixed asset valuation. Specifically, cost efficiency remains largely invariant across the spectrum of fixed asset values, exhibiting only a marginal decline in the upper two quintiles. In contrast, technical efficiency presents a more nuanced pattern that manifests as an inverse-U curve. It escalates from the first to the second quintile, maintains a plateau from the second to the fourth, and recedes in the apex quintile. This indicates that small utilities can gain efficiency by increasing their fixed capital stock, while large utilities can achieve efficiency gains by reducing their fixed capital stock. In other words, there is indeed such a thing as being too small or too big.

Ownership and management also play an important role in the efficiency and performance of utilities. The IBNET data can identify most utilities by ownership type, such as municipal, regional, or national, although some remain unidentified. Instead of removing these unidentified utilities from the analysis, they are drawn together into another group.[15] The classification of utilities by type shows that municipal-level service providers are generally more cost-efficient than regional or national service providers. Figure 3.3.10 suggests that median municipal service providers have

FIGURE 3.3.9 **Median Cost Efficiency and Technical Efficiency, by Deciles of Fixed Assets**



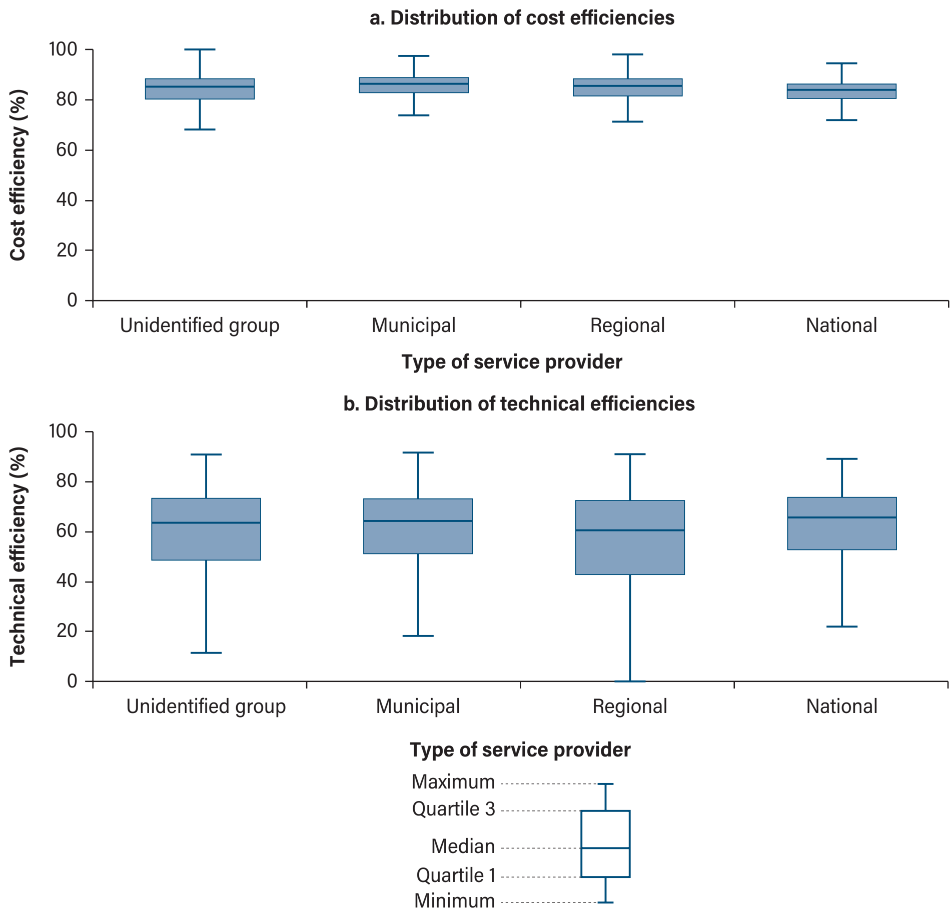
Source: Authors' estimation using IBNET data
Note: Graphs is a smoothed representation using local polynomial smoothing.

higher efficiency levels than their regional or national utility peers. The distributional analysis by ownership type suggests that the median cost efficiency of municipal utilities is 86.3 percent, compared to 85.5 percent and 83.9 percent for the regional and national-level utilities, respectively. The distribution of municipal utilities is also more compact than the other two types, suggesting more homogeneous performance than the regional or national utilities. Variability is highest among the national-level service providers.

Figure 3.3.11 summarizes the above discussion. Municipal utilities slightly outpace the average, with a cost efficiency of 86.3 percent and a technical efficiency of 63.9 percent. In contrast, while having a cost efficiency of 85.5 percent—close to the average—regional utilities display a notably lower technical efficiency, 60.2 percent. National utilities present a unique profile: they have the lowest cost efficiency, at 83.9 percent, but lead in technical efficiency (65.3 percent). Water utilities categorized as an unidentified group have efficiencies that hover near the overall average, with a cost efficiency of 85.2 percent and technical efficiency of 63.2 percent. This divergence in efficiencies across ownership types underscores potential variations in operational, technical as well as management practices, suggesting the importance of tailored strategies for each category.

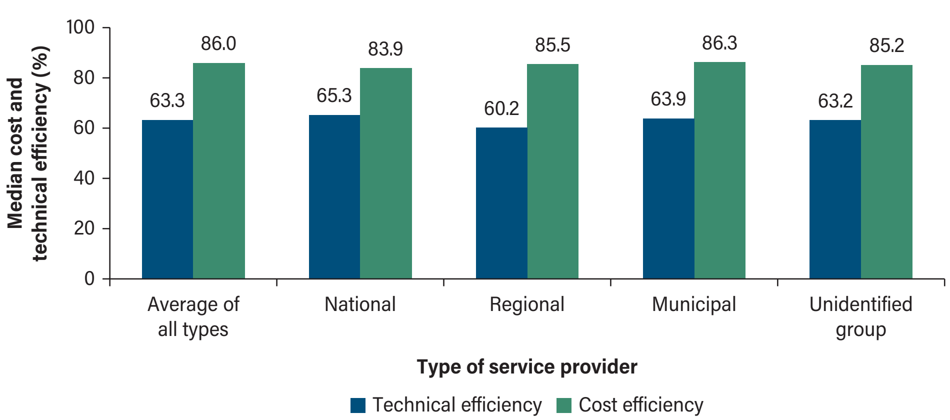
Small utilities can gain efficiency by increasing their fixed capital stock, while large utilities can achieve efficiency gains by reducing their fixed capital stock.

FIGURE 3.3.10 The Distribution of Cost and Technical Efficiencies and Median Efficiency, by Type of Service Provider



Source: Authors' estimation using IBNET data

FIGURE 3.3.11 Median Cost Efficiency and Technical Efficiency, by Type of Service Provider



Source: Authors' estimation using IBNET data

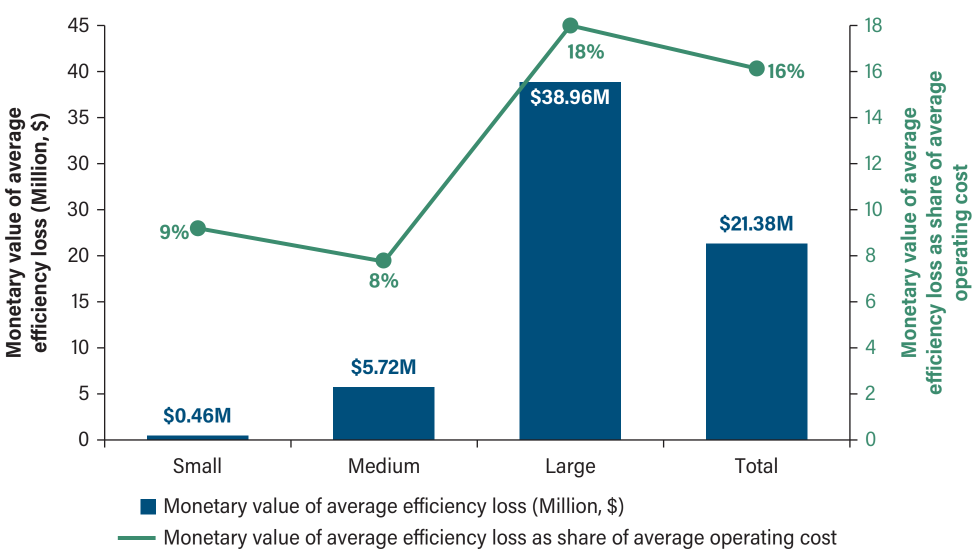
THE HIDDEN COST OF EFFICIENCY LOSSES

Efficiency losses can be thought of as hidden costs that water utilities incur. The monetary value of the loss in cost inefficiency can be calculated as the product of the inefficiency of each utility and the average total operating cost over the 2004–17 time period, in US dollars at 2015 prices, for that utility. This calculation is based on available data for 1,557 utilities[16] from 67 countries. The monetary value of cost inefficiency for each utility is calculated as a pooled average of all 14 years separately, for each year between 2004 and 2017. The average value of loss for a country is calculated as the average total loss across all utilities in that country for all years. The monetary value of total efficiency loss by size, region, or service provider type is calculated in the same way.

We found that, globally, the value of efficiency loss over the 2004–17 period, in 2015 prices, averaged $21.38 million per year per utility. This is 16 percent of the average annual total operating cost of the 1,557 utilities in our analysis. Figure 3.3.12 presents the monetary value of average loss (at 2015 constant prices) by size stemming from cost inefficiency. Small utilities had the lowest average efficiency loss, at $460,000, which constituted about 9 percent of their average annual total operating cost. Medium-size utilities had higher average efficiency losses of $5.72 million, but this comprised a smaller proportion of their annual average total operating cost—constituting about 8 percent. Large utilities had the highest average efficiency loss value, $38.96 million in 2015 prices, corresponding to 18 percent of their annual total operating cost on average.

The value of efficiency loss over the 2004–17 period, in 2015 prices, averaged $21.38 million per year per utility.

FIGURE 3.3.12 Monetary Value of Average Efficiency Loss as a Share of Average Operating Cost, by Utility Size (2015 constant prices)

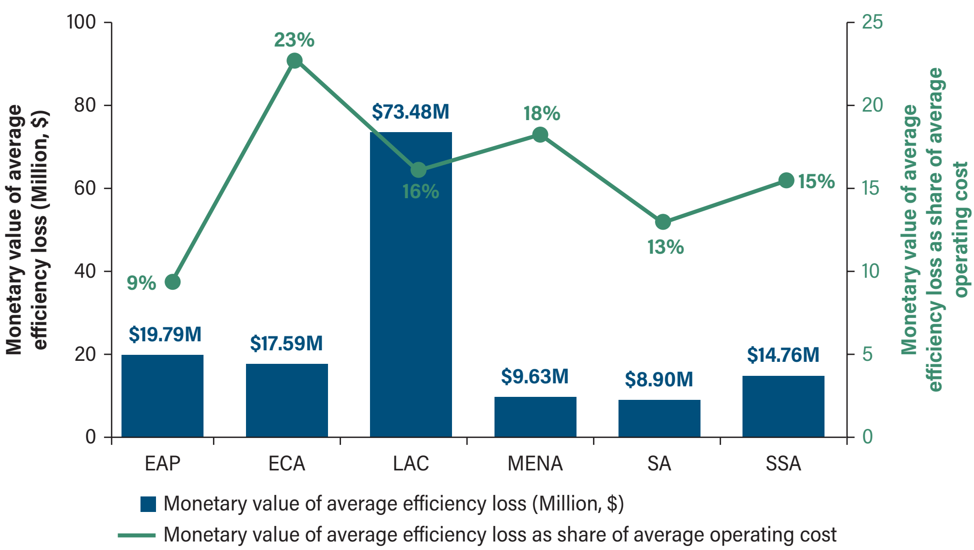


Source: Authors' estimation using IBNET data.
Note: Instead of using deciles of population served, utilities are grouped into terciles—small, medium and large.

Delving into the efficiency loss across diverse regions, intriguing patterns emerge that govern the interplay between efficiency loss, operational costs, and geographical scope (figure 3.3.13).[17] In EAP, the average monetary value of efficiency loss per utility is $19.79 million in 2015 prices, constituting 9 percent of the average operating cost (the lowest share among the regions). In ECA, the average efficiency loss is $17.59 million, a substantial 23 percent of average operating cost. In LAC, the efficiency loss is notably higher, at $73.48 million, representing 16 percent of utilities' average operating cost. The MENA region has average annual efficiency losses of $9.63 million per utility, amounting to 18 percent of the average operating cost. Efficiency losses in South Asia (SA) are relatively minimal at $8.90 million, equivalent to 13 percent of a utility's average operating cost. The SSA region's efficiency loss of $14.76 million constitutes 15 percent of a utility's average operating cost.

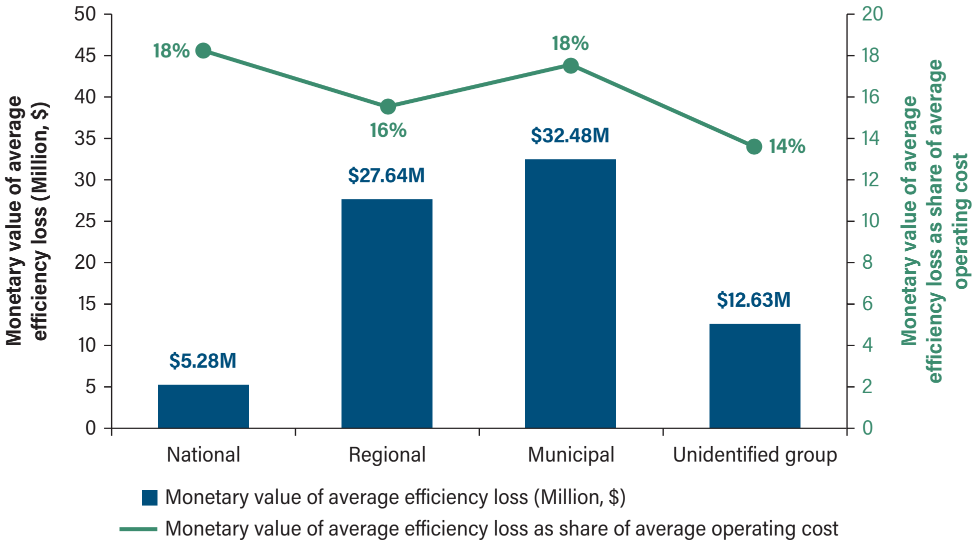
Figure 3.3.14 illustrates the distribution of efficiency loss across diverse water utility service provider types. Among national water utilities, the average monetary value of efficiency loss is $5.28 million, constituting 18 percent of average operating cost. Regional utilities, on the other hand, post higher efficiency losses, averaging $27.64 million—16 percent of their average operating cost. Similarly, municipal utilities' average efficiency loss of $32.48 million makes up 18 percent of their total mean operating cost. Utilities classified as unidentified in terms of ownership face an efficiency loss of $12.63 million, on average, accounting for 14 percent of their average operating cost. This analysis underscores the intricate and somewhat indeterminate relationship between efficiency loss, operational costs, and the ownership structure of water utilities.

FIGURE 3.3.13 Monetary Value of Average Efficiency Loss as a Share of Average Operating Cost, by Region (2015 constant prices)



Source: Authors' estimation using IBNET data.
Note: EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa; TFP = Total factor productivity.

FIGURE 3.3.14 Monetary Value of Average Efficiency Loss as a Share of Average Operating Cost, by Service Provider Type (2015 constant prices)



Source: Authors' estimation using IBNET data

Though the monetary value of the total loss from cost inefficiencies offers a conveniently simple financial metric, it does come with a few caveats. First, the IBNET data have significant missing value challenges; for instance, they do not contain output and input values for all utilities for all the years across the regions for which some data are reported. This almost certainly results in a selection bias that affects the estimates.

Second, because of the sparse data, we analyzed only those utilities that had at least 7 years of data (that is, 50 percent of the 14 years in the sample for each country) and then the missing values are imputed, as described in appendix F. Despite these accuracy concerns, the monetary estimates of efficiency losses presented here reveal the significant hidden costs water utilities face throughout the developing world. From a policy perspective, although IBNET data contain valuable information, they need to be updated regularly to make them complete in order to yield a more accurate understanding of the challenges water utilities face, and how they can be supported to cut their efficiency losses.

CORRELATES OF WATER UTILITY EFFICIENCY: DO SYSTEM-LEVEL AND COUNTRY-LEVEL FACTORS MATTER?

Unraveling the interplay between utility efficiency, on the one hand, and systemic and country-specific factors, on the other, is crucial because it offers insights into the correlates of efficiency, which in turn can guide comprehensive interventions to support water utilities.

Employing a censored regression model, the study examined system-level indicators such as type of ownership, design capacity, network length, gross fixed assets, and new investments per capita. Also integrated as control variables were a range of country characteristics—including governance (regulatory quality and the rule of law); environmental, energy, and natural resource utilization (such as industrial freshwater withdrawals, coal-based electricity production, primary energy source intensity, and water stress levels); and demographics (population density) taken from the World Development Indicators and World Governance Indicators. The study also adjusted for temporal and country-specific variations through country- and time-fixed effects. Given the nested structure of the data, a random-effects model was considered more appropriate than a fixed-effects approach.

Two Model Specifications

Table 3.3.4 presents the results from two model specifications: the first is with all the covariates discussed above; the second includes the interaction between ownership type and utility size. Utility size is included as terciles of population served, the three groups being small, medium, and large. Since the reference groups in our results were the "small size" for the variable denoting the size, and the "municipal type" for the variable denoting ownership type, all interpretations—including those involving interaction terms—were made in comparison to these reference groups.

TABLE 3.3.4 Correlates of Efficiency Estimated by Random-Effects Tobit Models

	(1) Cost efficiency	(2) Technical efficiency	(3) Cost efficiency	(4) Technical efficiency
Type of utilities (municipal as reference)				
Regional	−0.018***	−0.052***	−0.024***	−0.123***
National	0.007	−0.036**	−0.001	−0.105***
Unidentified group	0.007***	−0.028***	0.037***	−0.000
Size of service providers (small as the reference)				
Medium	0.032***	0.073***	0.031***	0.053***
Large	0.050***	0.096***	0.062***	0.048***
Interaction of size and type				
Regional mid-size utilities			0.015***	0.100***
Regional large utilities			−0.003	0.168***
National mid-size utilities			-0.012	0.059
National large utilities			0.043*	0.262***
Unidentified mid-size utilities			−0.022***	−0.045***

table continues next page

TABLE 3.3.4 Correlates of Efficiency Estimated by Random-Effects Tobit Models (*Continued*)

	(1) Cost efficiency	(2) Technical efficiency	(3) Cost efficiency	(4) Technical efficiency
Unidentified large utilities			−0.057***	−0.003
Other system level indicators				
Design capacity of water intake per unit population coverage	−0.000***	0.000***	−0.000***	0.000***
Length of network per unit population coverage	0.020	0.179**	0.023	0.161*
New investment per unit population coverage	−0.000***	−0.000***	−0.000**	−0.000***
Country-level WDI (World Development Indicators) and WGI (Worldwide Governance Indicators) control variables				
Regulatory quality, estimate	0.024***	0.059***	0.029***	0.065***
Rule of law, estimate	0.003	−0.031***	0.003	−0.014
Annual freshwater withdrawals, industry (share of total freshwater withdrawal)	0.110***	−0.002	0.092***	−0.012
Electricity production from coal sources (share of total)	0.062***	−0.104***	0.067***	−0.089**
Energy intensity level (GDP, PPP ($ 2011)	0.319***	0.611***	0.299***	0.678***
Fossil fuel energy consumption (share of total)	−0.017	0.367***	-0.042**	0.361***
Level of water stress: freshwater withdrawal as a proportion of available fresh water	−0.080***	−0.026	-0.065***	0.000
Population density (people per sq. km of land area)	0.002	−0.017**	0.000	−0.013*
Time effect	Yes	Yes	Yes	Yes
Country effect	Yes	Yes	Yes	Yes
sigma_u	0.068***	0.138***	0.068***	0.138***
sigma_e	0.055***	0.107***	0.055***	0.105***
Constant	0.807***	0.252***	0.824***	0.276***
Observations	20,566	20,645	20,566	20,645
Number of utilities	1,547	1,554	1,547	1,554

Source: Authors' estimation using IBNET data
Note: PPP = Public–private partnerships; WDI = World Development Indicator; GDP = Gross domestic product.

While regulatory quality positively influences both cost and technical efficiencies, the rule of law does not significantly affect these outcomes.

In the regression analysis, municipal utilities typically exhibited higher cost efficiencies and technical efficiencies than regional utilities. While they outperformed national utilities in technical efficiency, they slightly underperformed them in cost efficiency, although not by a significant amount. Of note, medium and large utilities appeared more efficient in both aspects than small utilities. This finding differs from the previous descriptive analysis, where small utilities were more cost-efficient than their larger counterparts.

Possible Interpretations

There are two potential reasons for this discrepancy. First, the coefficients from the linear regression estimation reflect the fact that averages across groups can be influenced by outliers. In contrast, our earlier analysis, which focused on measures such as medians and quartiles, is less affected by extreme values. Second, the regression model accounts for specific utility characteristics and broader country metrics. So after controlling for all variables, the results suggest that small utilities may not be as efficient as previously believed.

Utility efficiency varies significantly based on the interplay between utility ownership type and size. Certain combinations of utility type and size showed significantly different levels of efficiency compared to their respective reference groups. For example, mid-sized regional utilities demonstrated enhanced efficiency levels, while their counterparts in the unidentified group exhibited lower cost and technical efficiency. Large regional utilities were better only in technical efficiency, while those categorized as unidentified were the least cost-efficient. In summary, efficiency dynamics are complex, with ownership type and size combinations playing a crucial, but not always predictable, role in determining outcomes.

Design capacity of water intake. When adjusted for population, the design capacity of water intake negatively impacts cost efficiency but boosts technical efficiency. This is logical: A superior design capacity can enhance production efficiency by yielding more from the given input, but this often comes with increased costs. Notably, this impact is relatively minor in scale. The length of the network, adjusted for population, has a marginally positive impact on technical efficiency but does not influence cost efficiency. This is likely because it allows for providing services to a larger population. On the other hand, new investments per capita can affect both cost and technical efficiencies, but this is significant only in the latter and the effect is relatively marginal. This is understandable because over-relying on fixed assets can result in suboptimal capital utilization.

The Role of Country-Level Governance Indicators

Next, country-level governance indicators reveal that while regulatory quality positively influences both cost and technical efficiencies, the rule of law does not significantly affect these outcomes. Additionally, regions that have denser populations show enhanced cost efficiency, likely because concentrated populations incur lower per-capita water supply costs.

In conclusion, the efficiency of water utilities is deeply interwoven with operational and national characteristics in any given country. Understanding the relationships among operational features and broader national characteristics can guide targeted interventions to address specific ownership-based and size-based inefficiencies. Policymakers should prioritize sustainable water resources management to ensure cost-effective utility operations. Moreover, the pivotal role of design capacity in efficiency highlights the need for careful planning in determining investments in infrastructure development and technology upgrades.

Concluding Remarks

MAIN FINDINGS—TWO PERSPECTIVES

Analyzing productivity and efficiency in the WSS sector is crucial if governments and policymakers are to understand how public resources are allocated and marshalled to meet the basic needs of their populations. The analysis in this chapter employs two perspectives—the productivity and efficiency of national public spending, and the cost and technical efficiency of water utilities—to better understand a number of critical issues.

The first perspective. The first perspective involves examining whether countries are spending public resources to attain their water and sanitation access targets in the most productive and efficient way. The analysis aims to provide insights into the components that influence WSS sector productivity and efficiency and inform policy decisions that can help improve efficiency and better allocate public resources. The study found that, from 2009 to 2020, the productivity of basic and higher-level services declined about 5–6 percent in 58 countries, mainly due to substantial efficiency losses. This finding suggests a significant opportunity to improve both scale efficiency and pure efficiency and achieve the same level of access improvements with less public spending. Further, the analysis shows significant country-to-country variation in productivity and efficiency in public spending in the WSS sector.

METHODOLOGICAL LIMITATIONS

It is, nonetheless, essential to acknowledge some limitations of this analysis. First, the analysis assumes neutral technical change over time, which may not be true. Additionally, the analysis does not distinguish CAPEX and OPEX at different service levels and subsectors of WSS. Finally, although the DEA model used in this study is a widely accepted method for measuring efficiency, it does have some limitations, including over-sensitivity to outliers and potential biases.

> ***The efficiency of water utilities is deeply interwoven with operational and national characteristics in any given country.***

As suggested by the findings of this analysis, governments should prioritize improving both scale and pure efficiency in the WSS subsector in order to attain higher productivity and to allocate public resources more effectively. Governments can do this by identifying inefficiencies in capacity utilization and economies of scale by implementing policies that promote best practices, by investing in the training of staff, and by promoting performance-based contracts.

The second perspective. The second perspective employed in this analysis is to evaluate the efficiency of water utilities in providing drinking water, using data from the IBNET for Water and Sanitation Utilities. This lens aims to evaluate the performance of water utilities and identify possible inefficiencies in their operations. First, at the system level, the regression analysis found that medium and large utilities tend to be both more cost-efficient and more technically efficient than small utilities. The study also found that better design capacity positively correlates with technical efficiency. Among national-level indicators, a better regulatory environment positively correlated with higher technical efficiencies, although at higher cost. These findings have significant implications for bridging the water sector investment gap and achieving SDGs targets 6.1 and 6.2. Governments and policymakers can learn from these findings to identify areas for improvement and implement policies that can lead to increased efficiency and the better allocation of public resources in the WSS subsector.

Notes

1. Total factor productivity is a measure of how much output can be produced by a given level of inputs.
2. Technological change refers to a change in the production frontier with no change in inputs.
3. Technical efficiency change measures the ability to obtain maximal output from a given set of inputs, implying the best utilization of resources.
4. Pure efficiency change measures the change in efficiency due to changes in management, motivation of labor, optimal use of resources etc., while scale efficiency is defined as the ability of each utility to operate as close to its most productive scale size as possible.
5. We did not present an estimation of safely managed service level because we had only a limited number of observations of output variables. Among the 58 countries in the study sample, only 11 had data on their access rates to safely managed service levels in WDI.
6. These access rates are from the Joint Monitoring Programme (JMP) database.
7. Since the TFPCH is a multiplication of TECCH and EC, to easily understand the index, the multiplication can be linearized by taking the logarithm of the indexes and then adding them up. The positive logarithm value corresponds to an index larger than 1, and the negative logarithm value corresponds to an index smaller than 1. One corresponds to stagnation status. Adding the two values obtained after logarithmic transformation equals the percent change in TFPCH. The same idea also applies to the decomposition of technical efficiency (EC) into two components—SECH and PECH. A geometric mean of 0.864 of all countries in the study sample means a decrease of 6 percent, on average, in the total factor productivity of spending to provide the basic level of WSS services over the 2009–2020 period.
8. The detailed decomposition of TFPCH is reported in appendix E.
9. We use a log-linear function instead of a Cobb-Douglas function because the dataset is large. The Cobb-Douglas form is used when the sample is small and not many degrees of freedom are needed (Estruch-Juan et al. 2020). Also, given a log–log model, the input–output relationships (beta coefficient) can be used as elasticities, or degrees of responsiveness. This can be useful to policymakers for future programming. Additional details are shared in appendix F.

10. The IBNET data, however, have several caveats that pose significant difficulties in conducting a panel data analysis. This is further discussed in appendix F. For the analysis, only those utilities were included for imputation that had at least 7 years' worth of reported production and operating cost data, or 50 percent of panel data for each utility. Table F.2 presents a sensitivity analysis to examine the impact of data imputation, which is relatively marginal, as shown by the standard deviations of the efficiency (σ_u).
11. Since the efficiency values obtained from the Stochastic Frontier Production Function estimation are bounded between 0 and 1, we censored values at both 0 and 1 to create the floor and the ceiling of values.
12. For this analysis, the size of a utility is defined as the population served in their service area. The utilities are classified into three groups- small, medium and large, based on terciles of the population coverage. Small utilities cover a population less than 18,650, medium utilities cover a population rage of 18,650 and 146,663 and large utilities cover a population above 146,663.
13. Note that in our earlier analysis, we used median and percentile distributions by type and size of utility. The reason for using medians and percentiles and avoiding the mean was to circumvent the influence of extreme values.
14. A *boxplot* is a summary of data in graphical form. The top and bottom horizontal lines, ending in a T, are the maximum and minimum values respectively in the dataset. The line splitting the box in two is the median (or 50th percentile), which shows that 50 percent of the data lies on top of the median value and 50 percent lies at the bottom of the median value. The line showing the top of the box is the upper quartile (or 75th percentile), which shows that 75 percent of the data lies below this line (or conversely, 25 percent of the data lies above this line). Similarly, the bottom line of the box is the lower quartile (or 25th percentile) showing that 25 percent of the data lies below this line. Often boxplots also include outliers as dots outside of the boxplot. But the graphs here exclude these values.
15. Water utilities are classified by ownership type: municipal utilities (1,005) are the most numerous, followed by regional utilities (284), and then those with unspecified ownership, at 259. National utilities (23) are the least represented.
16. Utilities that lack information about their characteristics, such as their size and the type of service they provide, have been excluded from this section going forward in the analysis.
17. It should be noted that the representation of utilities from each region is not exhaustive. Some regions are over-represented, and some others have limited representation. These interpretations should therefore be handled with caution. Among the 1,571 water utilities, LAC is the most populous, with 786 utilities, followed by ECA with 408, EAP with 168, SSA with 156, SA with 32, and MENA with 21 utilities.

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CHAPTER 3.4

The Great Divide

KEY MESSAGES

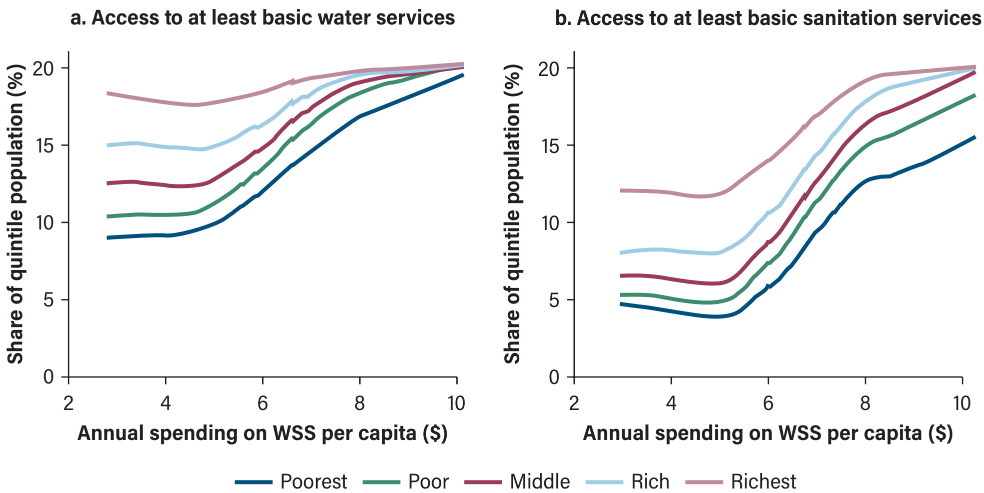
- Governments frequently offer subsidies to help close gaps in affordability caused in part by the resource constraints faced by providers and consumers.
- In the water sector, consumption subsidies often generate cost recovery and efficiency challenges.
- By targeting public resources to those in need, well-designed consumption subsidies may help reduce inequalities in access to higher-level services, such as piped water and sewer networks.
- Among the countries studied, except for Viet Nam and the Dominican Republic, a higher proportion of wealthier households received water consumption subsidies than poorer households. The degree of regressivity was particularly pronounced in Sub-Saharan Africa.
- The regressivity of water consumption subsidies observed in many countries is often a result of historical inequities long ago "baked" into the geographical distribution of the piped water network and the sewer infrastructure—in short, a product of political choices made in a much earlier time, and the path dependency created by those decisions.

Inequities in Access to Services

In the developing world, inequities in access, particularly for water supply and sanitation (WSS) services, can be widely observed between one income level and another, and between one geographic location and another, with greater access for more affluent and urban population segments. Because of the widespread social exclusion along ethnic, religious, and gender lines faced by many, especially the poor and the vulnerable, market forces alone are often not adequate to ensure equitable levels of water services to all. Consequently, governments may need to intervene to address these inequalities by implementing targeted investments and programs for disadvantaged communities.

Evidence shows high inequity in access to basic WSS from one income level to another. Figure 3.4.1[1] illustrates using data from 125 countries, the degree of inequity in access to basic WSS services by wealth quintile (y-axis) at different levels of per capita spending on the WSS sector in several countries (x-axis). At every level of per capita spending, and in all countries in the sample, the graph shows a bias toward wealthier quintiles.

FIGURE 3.4.1 Correlation between Spending per Capita in the WSS Subsector and Access, by Quintile



Source: Authors' estimation using BOOST database (*N* = 125). WHO/UNICEF (2023).
Note: WSS = water supply and sanitation.

In good times, the poor may be catered for at the most basic service levels, but should a recession, war, or pandemic hit, they are almost always the first to bear the brunt of fiscal belt-tightening.

In other words, regardless of the level of per capita spending on WSS, access to WSS services is higher among the wealthy. Both panels of the graph show that, for both access to (at least) basic water services and access to (at least) basic sanitation services, the share of population that has access is larger in every quintile than it is in the one immediately below it and, in turn, the share of population with access in that quintile is larger than in the quintile below. The graph also reveals that when annual per capita spending is relatively generous, both the rich and the poor tend to have good, roughly equal access to basic WSS services. But when spending gets tighter, the first to suffer are the poor—and they suffer in order of quintile, with the very poorest suffering the most. In short, as the per capita spending rises, the poor households start benefitting more.

Additionally, with the numerous lateral connections that link the water sector in general, and the WSS subsector in particular, to other sectors of the economy, such low access to WSS services among those who face social exclusion based on ethnic, religious, and gender lines without doubt contributes to their experience of multidimensional poverty.

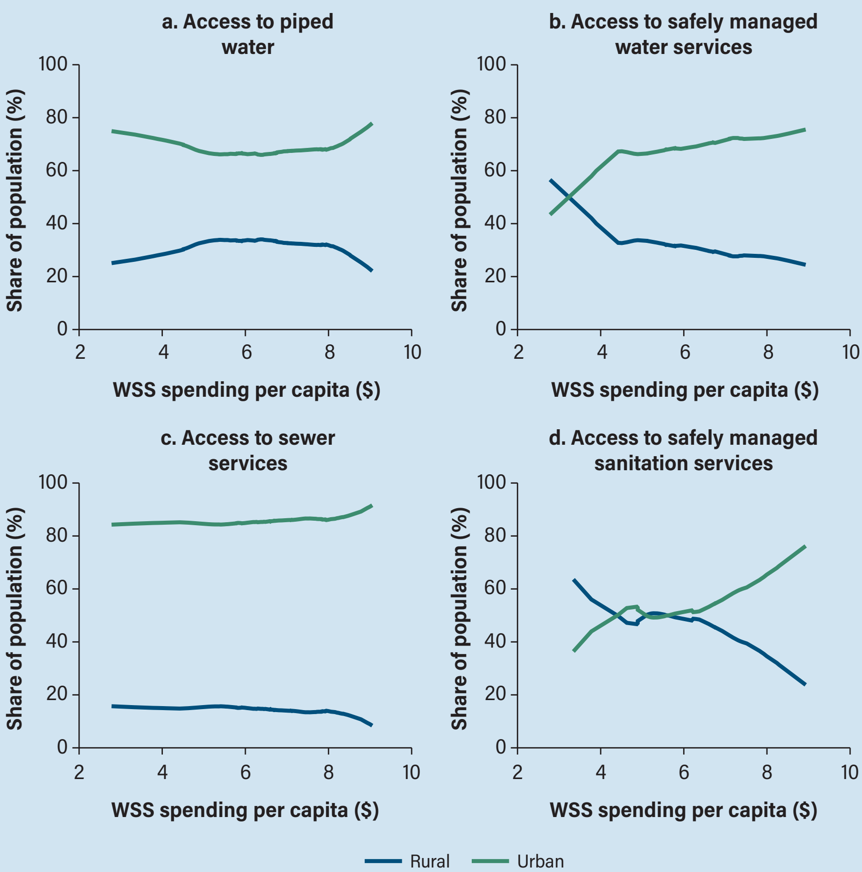
For basic sanitation services (panel b), it can be observed that the access gap between the two poorest quintiles and those above them persists even at the highest per-capita spending levels. This highlights the challenge of providing basic sanitation

BOX 3.4.1 The Urban–Rural Divide: How WSS Spending per Capita Affects Access to Safely Managed Water Supply, Sanitation and Hygiene (WASH) Services

Location of residence is often a primary determinant of who has access to services and economic opportunities, and who is excluded from them (Card, Rothstein, and Yi 2021). As shown in figure B3.4.1.1, there is a significant access gap on WSS services between urban and rural populations. Except for safely managed sanitation, there is an urban bias at almost all levels of spending and service type.

The magnitudes, however, vary. At lower WSS per capita spending levels, urban access to piped water and sewerage services is higher than rural; for access to safely managed water supply services, the urban access is much larger and persists even as spending increases. At lower levels of WSS per capita spending, the gap reverses for safely managed sanitation. This could potentially be due to the increased prevalence of shared sanitation and limited fecal sludge management in many urban areas.

FIGURE B3.4.1.1 Correlations between WSS Spending per Capita and Access by Service Type and by Level, Rural versus Urban Areas



Source: Authors' estimation using BOOST database; WHO/UNICEF Joint Monitoring Programme data (2023).

Note: Clockwise from (top right) Safely managed water access (*N* = 74); (bottom right) Safely managed sanitation access (*N* = 74); (bottom left) Sewerage access (*N* = 76); (top left) Piped water access (*N* = 126). WSS = water supply and sanitation. WSS total spending per capita is in natural logarithm form.

BOX 3.4.1 The Urban–Rural Divide: How WSS Spending per Capita Affects Access to Safely Managed Water Supply, Sanitation and Hygiene (WASH) Services (*Continued*)

Nonetheless, as WSS spending per capita continues to rise, urban access catches up with and surpasses rural access to safely managed sanitation. This pattern is driven by the type of technology countries select when they spend more on sanitation per capita: typically, they construct more sewer networks, in urban areas (which are more expensive) while in rural areas, cheaper alternatives like septic tanks or ventilated improved pit latrines are the preferred options. Still, the urban–rural gap in access to all higher level WSS service levels persists and widens as spending per capita increases.

This urban preference in investment has significant implications for public health and economic productivity. Urban areas, with their more complex infrastructure and higher population densities, naturally attract more WSS spending, which translates into better service levels. Meanwhile, rural regions, often limited by geographic and economic constraints, lag in receiving similar benefits. The resulting service gap not only highlights the need for targeted policy interventions to balance the scales of WSS access but also points to the broader challenge of equitable resource distribution in public services. Addressing this imbalance is crucial for sustainable development, ensuring that all populations, regardless of location, have the foundational support of reliable WSS services.

services to the most marginalized and suggest the need for stepping up per capita spending levels in sanitation to reduce the gap in access among the rich and the poorer quintiles.

Analyzing the Role of Subsidies

Targeted subsidies can be an effective way to direct increased WSS spending to the neediest. For low-income people, affordability is a significant barrier to accessing these services, especially higher-level services such as piped water supply and sewer networks. Well-targeted subsidies can help bridge this gap. Although they may lead to cost recovery and efficiency challenges for the service providers and incur fiscal costs to the governments, such subsidies tend to reduce inequality by directing public resources to the most vulnerable.

This section of the study uses Benefit Incidence Analysis (BIA) to evaluate the distribution of water consumption subsidies. The aim is to determine whether government spending in the WSS sector is progressive or regressive in its allocation. Drawing on the existing literature and on administrative and household data from selected countries, this study addresses several questions. First, we examine who are the primary beneficiaries of WSS public spending. Second, we analyze the share of households in different income groups that receive water consumption subsidies, and how important these subsidies are for households in each decile relative to their water expenditure.[2] Finally, we present a case study of Brazil to illustrate how BIA can be used to better

Targeted subsidies can be an effective way to direct increased WSS spending to the neediest.

understand the incidence of piped water consumption subsidies in a particular country context (Abramovsky et al. 2020; Angel-Urdinola and Wodon 2012).

Inequities in Access to Piped Water in Selected Countries

The analysis focuses on a select set of countries in Sub-Saharan Africa (SSA), East Asia and Pacific (EAP), Latin America and the Caribbean (LAC), and South Asia (SA) for which household survey data and administrative data on piped water unit costs and tariffs are available.

Table 3.4.1 presents descriptive statistics of the access rates of households connected to piped water in each country in 2017.[3] The proportion of households with access to piped water is reported for the country, in rural and urban areas, and for B40 (bottom 40 percent) households.

As expected, in all countries, access to piped water was higher in urban than in rural areas in 2017. However, there is significant variation across countries. For example, in 2017, the five LAC countries (Brazil, the Dominican Republic, El Salvador, Jamaica, and Panama) had relatively higher connection rates in urban areas than SA, EAP and SSA countries. Urban access to piped water was highest in Panama (99 percent), followed by Brazil (about 93 percent) and the Dominican Republic (about 87 percent). However, the urban–rural gap in access to piped water in Brazil is substantial, about 61 percent, and the highest among the 5 LAC countries, followed by Ethiopia and Sri Lanka, and the lowest in the Dominican Republic and Nepal. It is interesting to note, though, that the relatively lower gap in urban–rural access to piped water in Nepal is driven by low access in both urban and rural areas.

TABLE 3.4.1 Piped Water Coverage, by Country, 2017

Country	Region	Rural (%)	Urban (%)	Urban–rural gap (percentage points)	Total (%)	The bottom 40 percent
Dominican Republic	LAC	72.3	86.5	14.2	84.1	83.5
Nepal	SA	22.2	39.3	17.1	29.9	18.8
Panama	LAC	80.4	98.7	18.3	93.2	84.6
El Salvador	LAC	64.1	88.0	23.9	79.3	67.9
Viet Nam	EAP	28.8	70.2	24.2	53.0	50.4
Uganda	SSA	1.8	29.1	27.3	8.7	0.9
Mali	SSA	2.2	29.6	27.4	11.1	0.9
Bangladesh	SA	2.8	41.3	38.5	13.6	4.7
Jamaica	LAC	49.0	88.1	39.1	69.7	56.2
Niger	SSA	0.8	49.7	48.9	9.1	0.1
Sri Lanka	SA	25.3	77.4	52.1	34.0	23.0
Ethiopia	SSA	3.5	63.9	60.4	19.8	2.4
Brazil	LAC	31.7	92.8	61.1	83.8	76.5

Note: EAP = East Asia and Pacific; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa.

Among the four Asian (1 EAP and 3 SA) countries, Viet Nam (53 percent) has the highest overall connection rate, but the connection rate in rural Viet Nam is significantly lower. On the other hand, the SSA countries in our sample (Ethiopia, Mali, Niger, and Uganda) all have relatively low connection rates, with less than one-fifth of their general population connected to piped water. The disparities are much starker for Africa's rural population than their urban counterparts. Finally, in all countries except the Dominican Republic and Viet Nam, the B40 fare significantly to very significantly worse in their access to piped water than the overall population, clearly reflecting the pro- rich bias in piped water consumption subsidies.

Distribution of Water Consumption Subsides in Selected Countries

Figure 3.4.2 presents the allocation of water consumption subsidies across income groups by comparing the distribution of the beneficiaries across income or consumption deciles[4] and the proportion of total beneficiaries who receive the subsidies within each.[5] Overall, except for the Dominican Republic and Viet Nam, the proportion of piped water subsidy beneficiaries in each consumption expenditure decile is higher in the upper deciles than in the lower deciles. In other words, a higher proportion of wealthier households receive water consumption subsidies than poorer ones.

This is particularly pronounced in the African countries in our sample. For example, in Ethiopia, over 60 percent of the wealthiest 10 percent of households receive subsidies, while almost none of the poorest 10 percent receive any. It is similar in Mali, Niger, and Uganda, where about 30 percent or more of the wealthiest decile households receive water subsidies, and almost none in the poorest 10 percent receive any.

In Latin America, also, the subsidy distribution is relatively inequitable, but less so than in the African nations. For example, in Jamaica and Panama, even though over 70 percent of the richest 10 percent households receive subsidies, as much as 40 percent of the poorest 10 percent also receive subsidies. The distribution of subsidies is even less regressive in Brazil, where over 80 percent of the top 10 percent households receive subsidies, as do over 60 percent of the poorest 10 percent. By contrast, the distribution of subsidies is commendably equitable in the Dominican Republic: 80 percent of households in all 10 deciles receive subsidies, and the gap between the proportion of richest and poorest 10 percent of households who receive subsidies is small.

A higher proportion of wealthier households receive water consumption subsidies than poorer ones.

Among the two Asian countries included in this analysis, the subsidy distribution is quite regressive in Bangladesh, where over 20 percent of the wealthiest decile receive subsidies, compared to less than 5 percent of the poorest decile. In contrast, the distribution is significantly more equitable in Viet Nam, with more than 50 percent of households in all but two deciles receiving piped water subsidies.

FIGURE 3.4.2 Distribution of Water Subsidy Beneficiaries, by Income Decile

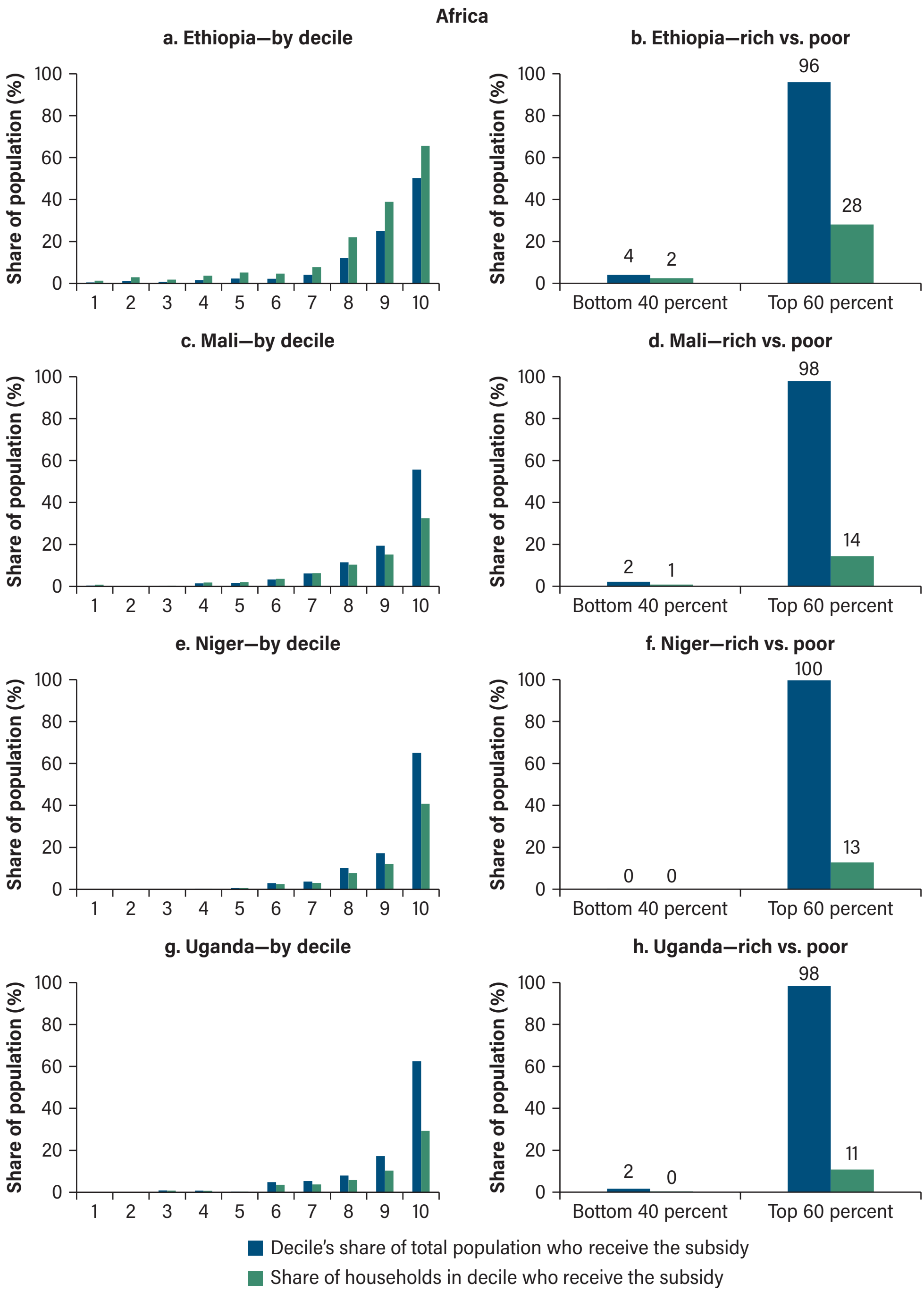


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FIGURE 3.4.2 Distribution of Water Subsidy Beneficiaries, by Income Decile *(Continued)*

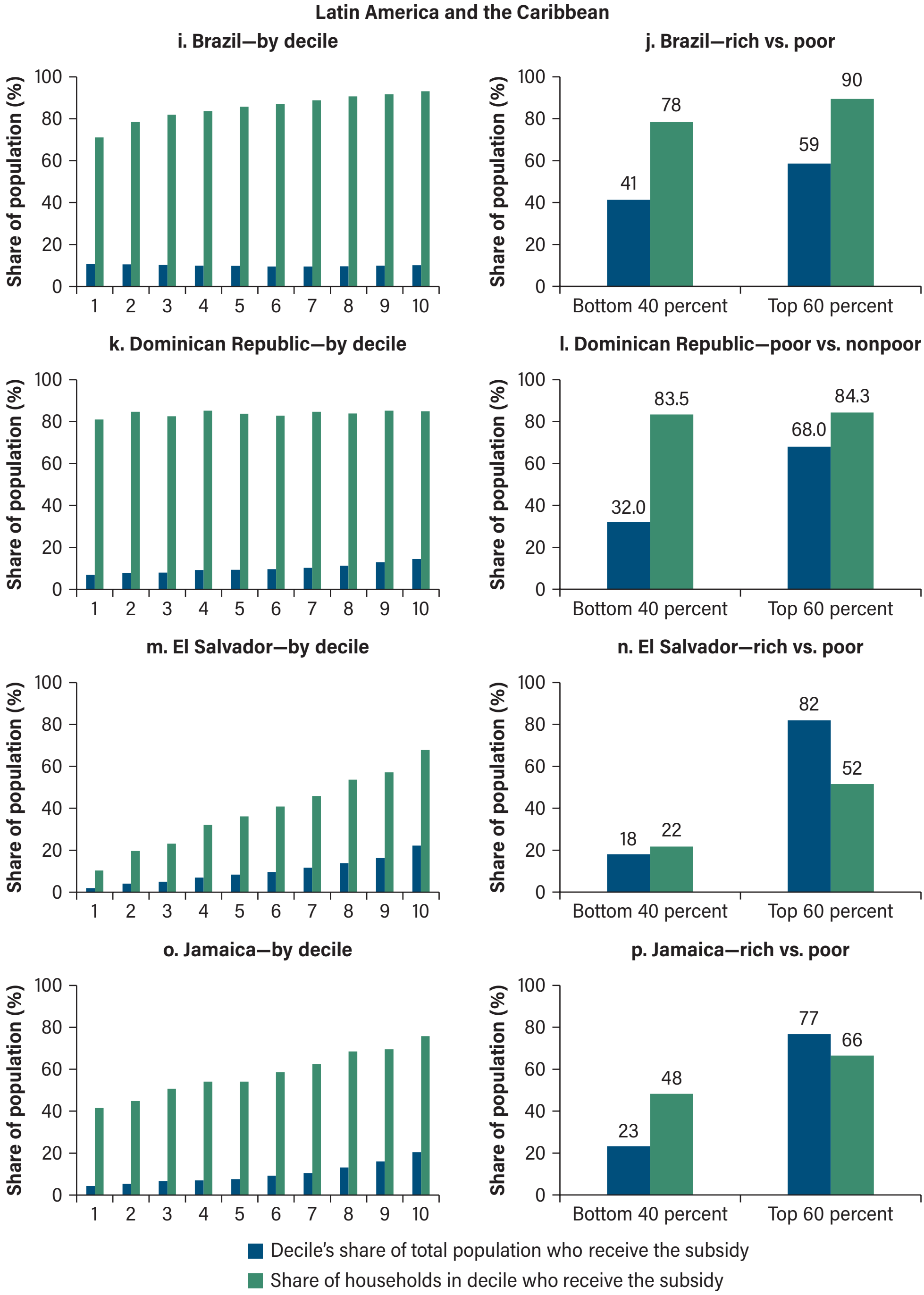

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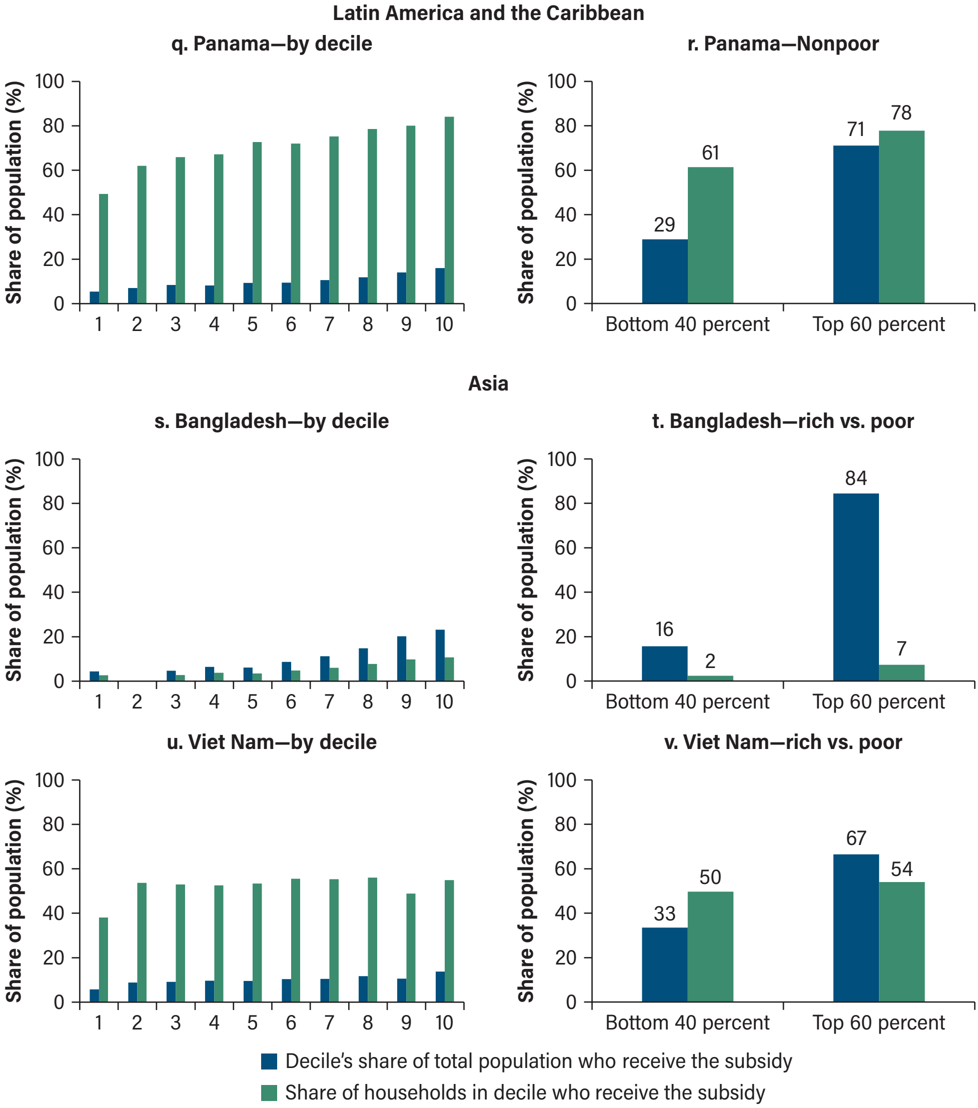
FIGURE 3.4.2 Distribution of Water Subsidy Beneficiaries, by Income Decile *(Continued)*



Note: Authors' elaboration using various household surveys.

Looking at each decile's share in total household water expenditure and in the piped water subsidy (figure 3.4.3), it can be observed that SSA countries in the sample have the most regressive distribution of subsidies, with the richest deciles receiving the most piped water subsidies. In Niger and Uganda, for example, the richest 10 percent receive approximately 70 percent of all the subsidies, while the poorest decile receives almost none. In Ethiopia and Mali as well, the richest receive close to 60 percent of the subsidies while households in the poorest decile receive almost none.

FIGURE 3.4.3 **Distribution of Subsidies Received versus Household Expenditure on Water, by Income Group**

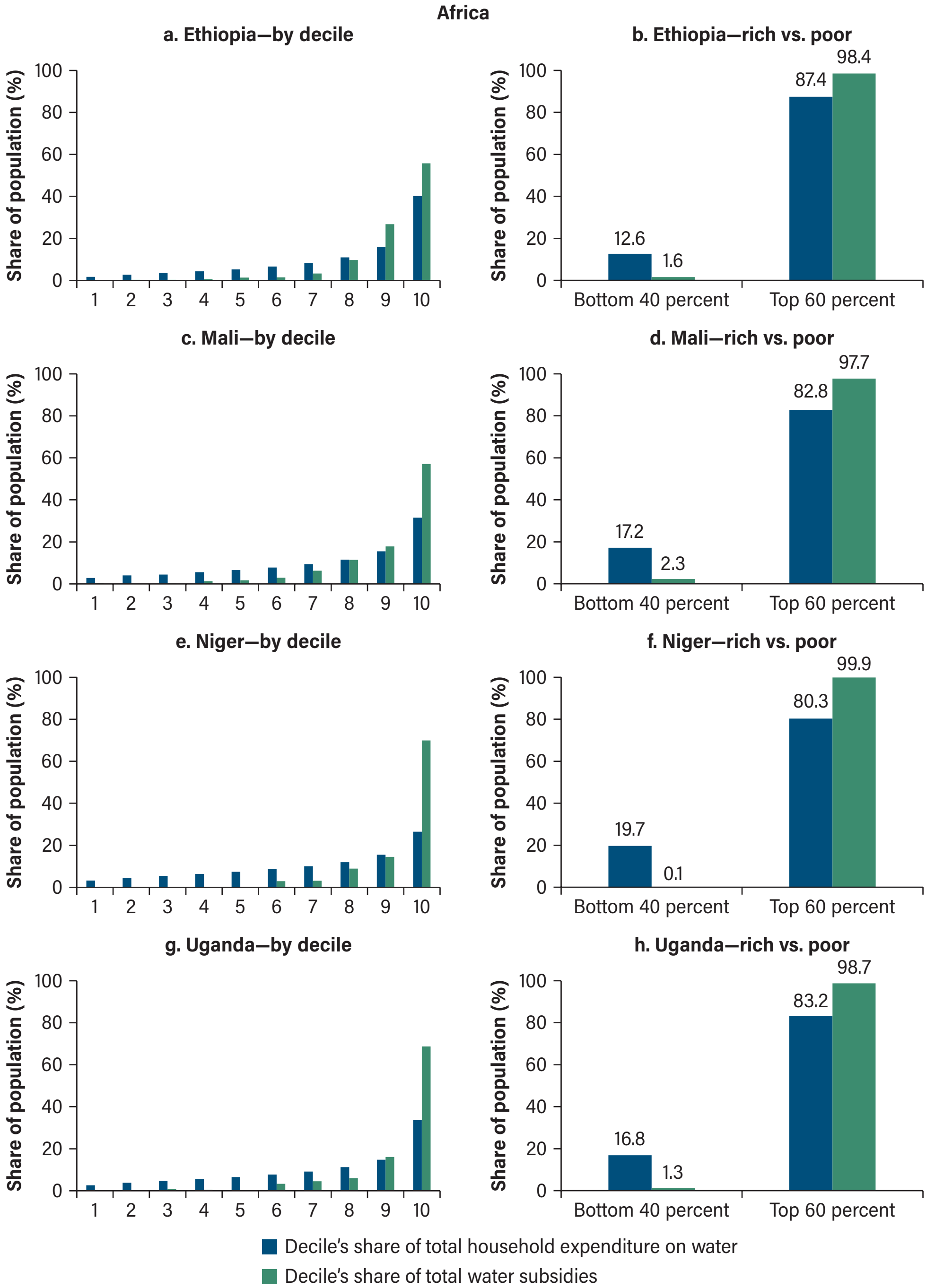


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FIGURE 3.4.3 **Distribution of Subsidies Received versus Household Expenditure on Water, by Income Group *(Continued)***

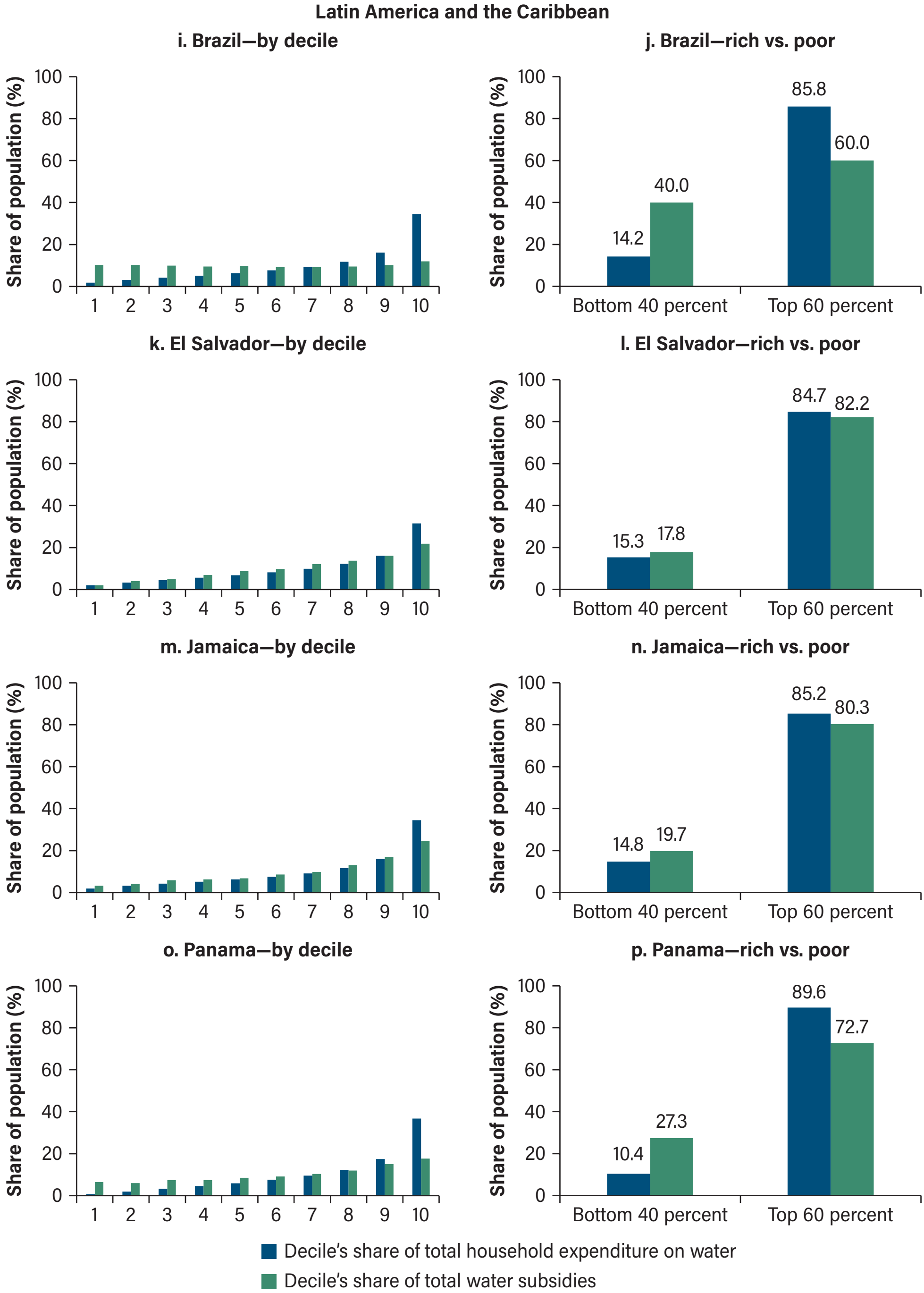

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FIGURE 3.4.3 Distribution of Subsidies Received versus Household Expenditure on Water, by Income Group *(Continued)*

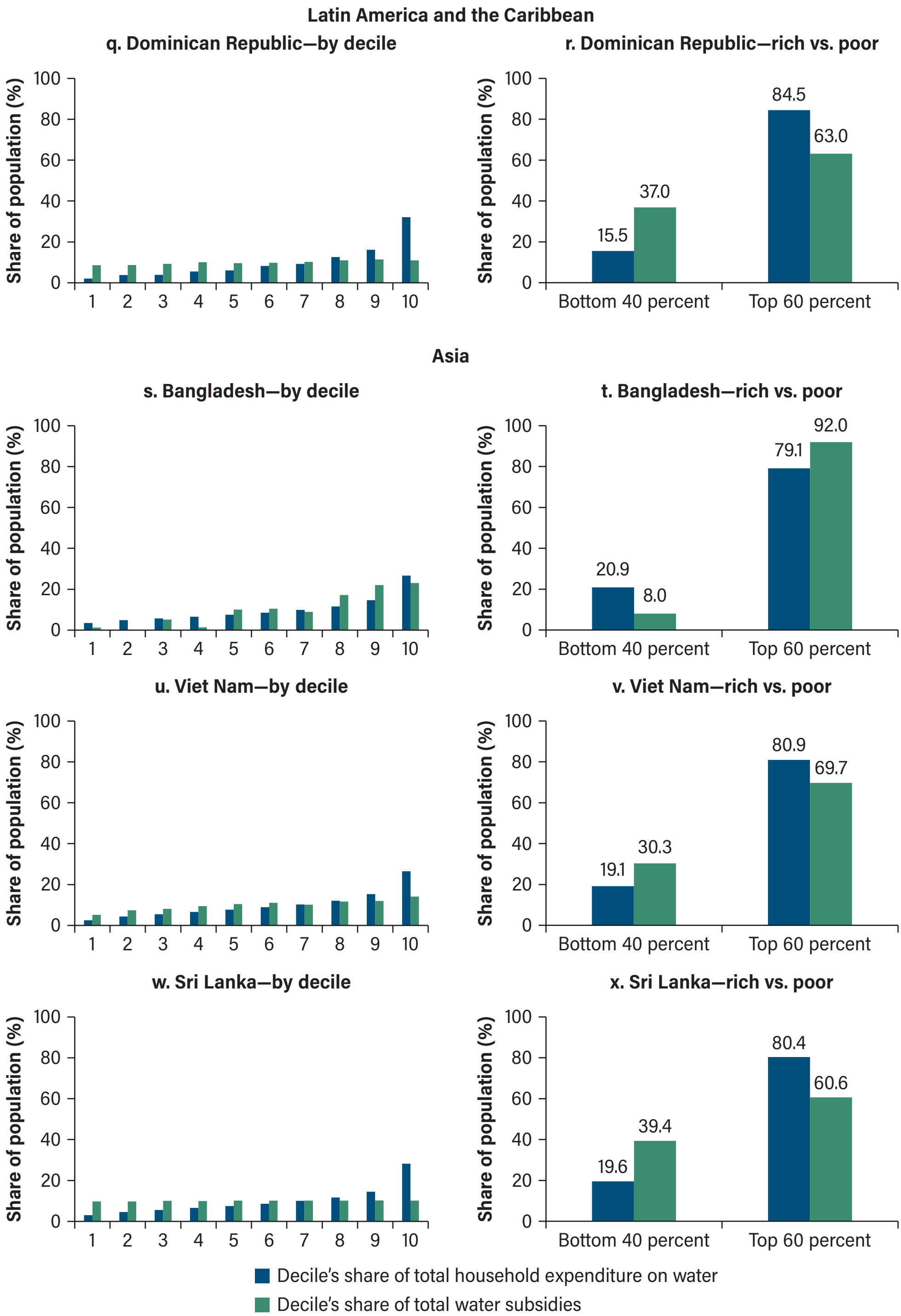

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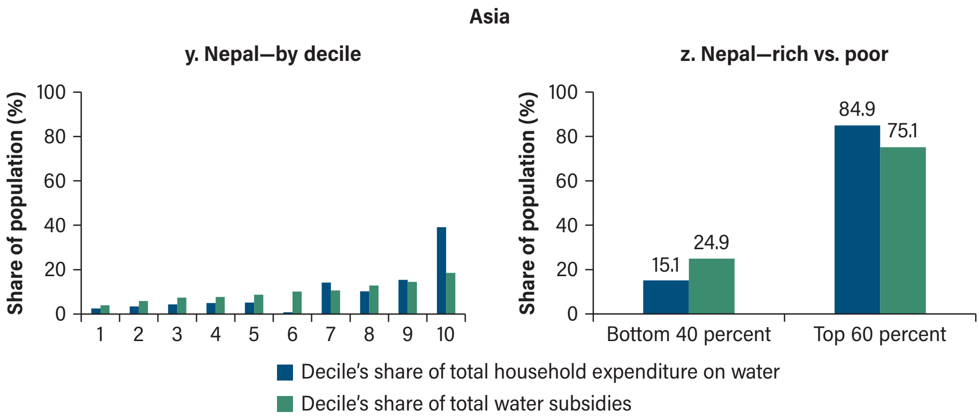
FIGURE 3.4.3 Distribution of Subsidies Received versus Household Expenditure on Water, by Income Group *(Continued)*



Note: Authors' elaboration using various household surveys.

The distribution in Latin America also is inequitable, but less so than that of African nations in the sample. For example, in El Salvador and Jamaica, the richest 10 percent receive more than 20 percent of the subsidies, while the poorest 10 percent receive much less than 5 percent. On the other hand, in the Dominican Republic and Brazil, the distribution of subsidies is close to equal for both the richest and the poorest.

The Asian countries in the sample show a degree of regressivity similar to the LAC countries. Bangladesh has the most regressive subsidy distribution, with the top 40 percent of households receiving over 70 percent. Nepal and Viet Nam also have regressive distributions but less so. In contrast, in Sri Lanka, the distribution of subsidies is close to 10 percent for all deciles.

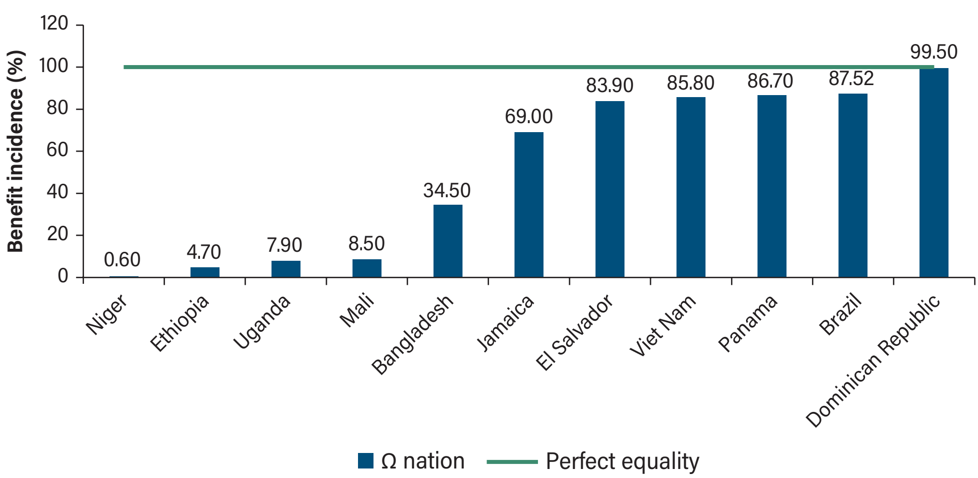
Examining decile shares in total national water expenditure and water subsidy for the B40 and T60 (top 60 percent) shows that, in SSA, poorer households collectively expend a smaller share of the country's total expenditure on water, but they also receive an even smaller share of the government's water subsidies. By contrast, the B40 households in Asian and Latin American countries (except for Bangladesh) in our sample receive a relatively larger share of the government's water subsidies than their African counterparts.

Targeting Performance of Subsidies

In this subsection, we discuss a summary measure of the benefit incidence of water consumption subsidies, incorporating both the share of the income group who receive the subsidy and the amount of subsidies received by the income group as a proportion of the overall population.[6] The benefit incidence targeting indicator (Ω)—pronounced "omega"—is defined as the ratio of the share of benefits that are received by the poor—defined as the bottom 40 percent of the expenditure distribution—to the share of poor households in the total population. The decomposition depends on both access-related factors, such as the share of poor households in a service area who are connected to the service network, as well as subsidy design factors, such as the share of poor households receiving a subsidy, the relative rate of subsidization for poor households, and the relative quantities consumed by poor households. An Ω (omega) value above 100 percent implies pro-poor targeting of subsidies, whereas a value below 100 percent means that subsidies are disproportionately targeted to the nonpoor households.

It can be observed that, for every country in the analysis, Ω falls below 100 percent, although Brazil, Panama, Viet Nam, and El Salvador have Ω values close to 90 percent, and the Dominican Republic is nearly 100 percent (figure 3.4.4). These five countries have relatively good targeting performance. Bangladesh has a low targeting indicator of 35 percent, but the SSA countries—Mali, Uganda, Ethiopia, and Niger—are the worst-performing, with Ω values lying in the 1–9 percent range.

FIGURE 3.4.4 Benefit Incidence (Ω), by Country

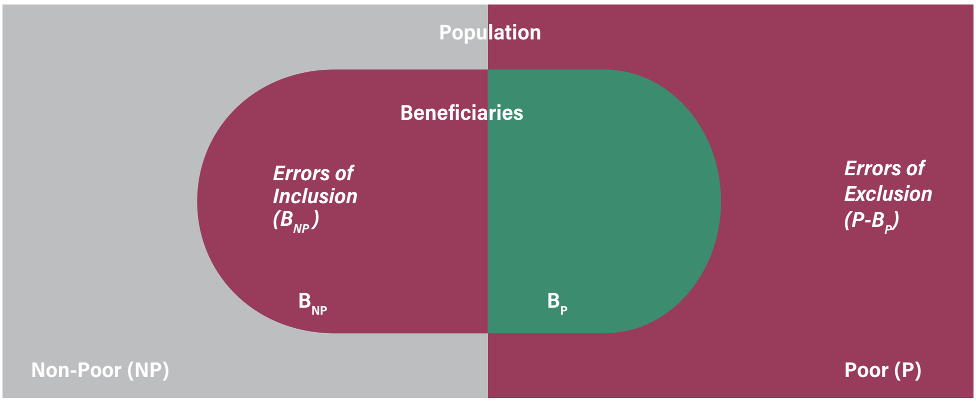


Errors of Exclusion and Inclusion

Two additional measures used to assess the targeting performance of subsidies are inclusion and exclusion errors (figure 3.4.5). Briefly, the exclusion error captures the share of poor households who should but do not benefit from the subsidy, that is, who are excluded from the beneficiary population. The inclusion error captures the share of nonpoor households who should not, but do, benefit from the subsidy.[7] Generally, the lower the error value, the better the targeting of subsidies in the country. In figure 3.4.5, the two red areas represent policy implementation errors:

All of P-Bp represent poor people who should be receiving the subsidy and are not, while B_{NP} represents nonpoor people who are receiving the subsidy but should not. If correctly targeted, all of the poor households would receive subsidies – hence the red rectangle would be green – and the nonpoor households would not receive any subsidies –the grey rectangle would not have any red middle.

FIGURE 3.4.5 Graphic of Errors of Inclusion and Exclusion

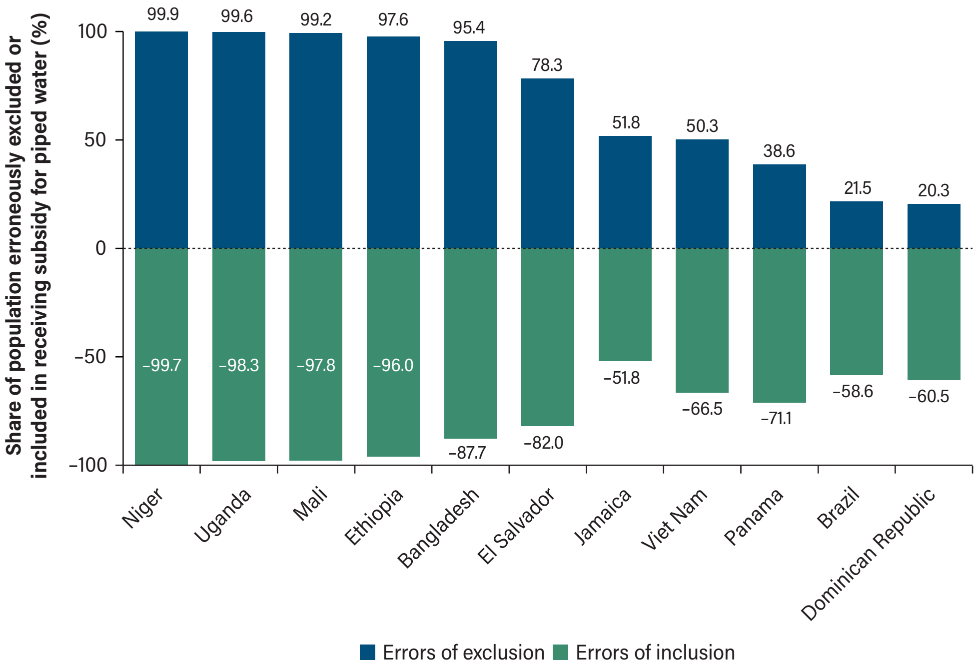


Note: P = The poor; NP = The nonpoor; BP = Share of poor households benefiting from the subsidy; BNP = Share of nonpoor households benefiting from the subsidy.

Consistent with the trends observed for the benefit incidence Ω, exclusion and inclusion errors tend to be very high for all SSA countries in the sample and for Bangladesh (ranging between 88 and 100 percent) (figure 3.4.6). Brazil and the Dominican Republic have high errors of inclusion but relatively low errors of exclusion. This indicates that although the government does spend enough to ensure that the subsidy reaches most poor people (low exclusion rates), there nevertheless are political economy weaknesses that have enabled sociopolitical elites to redirect a substantial portion of the piped water subsidy toward themselves (high inclusion errors).

In SSA and Bangladesh, by contrast, not only are government resources already meager in comparison to the gravity and extent of the need, but sociopolitical elites have captured most of what relatively few resources there are, while leaving the marginalized in a weak bargaining position and without enough of a voice to advocate for their needs—resulting in both high inclusion and high exclusion errors. In both sets of cases, nonetheless, the public budget—even without any attempt to augment it—could be much better prioritized to target subsidies more effectively toward vulnerable households. But this will have to include initiatives to make the poor less invisible, more easily identifiable, and more accurately countable, as well as efforts to render the political process of national resource bargaining more equitable and less subject to state capture.

FIGURE 3.4.6 Errors of Exclusion and Inclusion for Piped Water Consumption Subsidies in 11 Countries



Source: Authors' estimation from IBNET and various household surveys including Ethiopia: Ethiopian Socioeconomic Survey 2015/16; Mali: Enquête Modulaire et Permanente Auprès des Ménages (EMOP) 2014; Niger: National Survey on Household Living Conditions and Agriculture 2014; Nigeria: General Household Survey (GHS) Panel Wave-3 Survey 2015/16; Uganda: The Uganda National Panel Survey 2013/14; El Salvador: Encuesta de Hogares de Propósitos Múltiples 2016; Jamaica: Jamaica Survey of Living Conditions 2012; Panama: Encuesta de Hogares de Propósitos Múltiples 2015; Bangladesh: Household Income and Expenditure Survey (HIES) 2016; Viet Nam: Household Registration System Survey 2015; Brazil: Consumer Expenditure Survey–POF 2017/18

Note: Poor households are defined as belonging to the first four deciles of the expenditure (or income) distribution in each country. Error of inclusion is measured by the percentage of all beneficiary households that are rich; error of exclusion is measured by the percentage of poor households that do not get a subsidy. All figures are calculated using sample weights.

Benefit Incidence Analysis of Piped Water Subsidies in Brazil—A Case Study

ACCESS TO PIPED WATER IN BRAZIL—PERSISTENT INEQUITIES IN ACCESS

Brazil is a large populous economy. Data from the Pesquisa de Orçamentos Familiares (POF) Consumer Expenditure Survey indicate that, in 2017, about 84 percent (174 million) of Brazil's population of 207 million had access to piped water.[8] However, there are significant inequities in access to water and sanitation in the country, particularly among urban and rural populations. An estimated 93 percent of the country's urban population, but only 32 percent of rural dwellers, have access to piped water connections. Data from expenditure deciles, often a good proxy for household income distribution, also show that only 60 percent of Brazilians in the bottommost expenditure decile have access to piped water connections, versus 93 percent of those in the top decile.

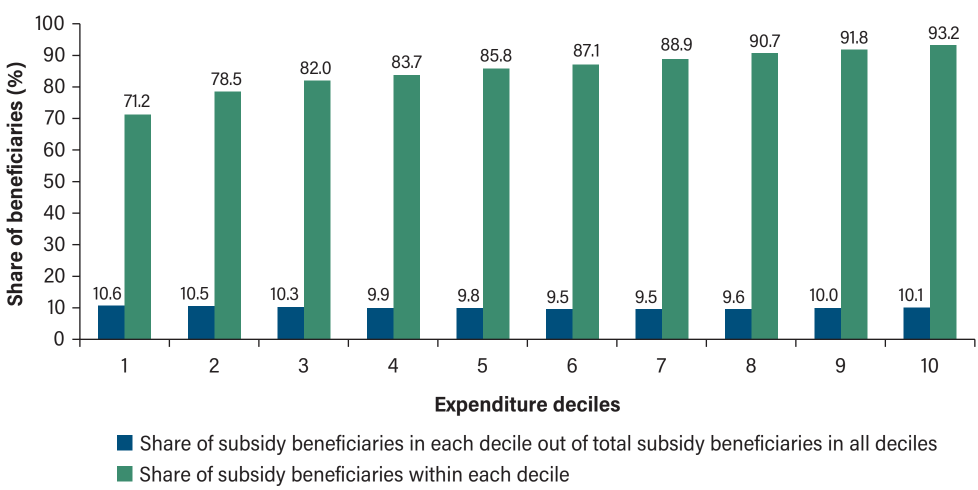
Although this income-based disparity is partly reflected in the urban–rural gap in access to piped water, it indicates that, in this service area—but perhaps also in others—the divide in Brazil is more fundamentally between its urban and rural populations. The access rate among the poorest 10 percent of Brazilians is almost twice that of the country's rural population, both poor and nonpoor, taken as a whole.

Following the urban–rural divide in access to piped water, access patterns also reflect regional disparities. Access is highest in the southeast region, at 92 percent. Not surprisingly, Sao Paulo, Brazil's most populous (and predominantly urban) state, has a 97 percent access rate. This is followed by the Federal District, in the central-west region, at 95 percent. But at 56 percent, access to piped water is considerably lower in the northern region, particularly for people living in the states of Rondônia, Acre, and Amapá (which are predominantly rural), where access rates are well below 50 percent.

COMPARING THE SHARE OF BENEFICIARIES IN BRAZIL'S EXPENDITURE DECILES

Figure 3.4.7 shows that the beneficiaries of Brazil's water consumption subsidies are very evenly distributed across the expenditure deciles. Despite their due share of 10 percent each, the two bottom most deciles have slightly more beneficiaries (10.6 percent and 10.5 percent, respectively) than in the top two deciles (10.0 and 10.1 percent, respectively).

FIGURE 3.4.7 Share of Water Subsidy Beneficiaries, by Decile; and Share of Beneficiaries in Each Decile Out of All Beneficiaries



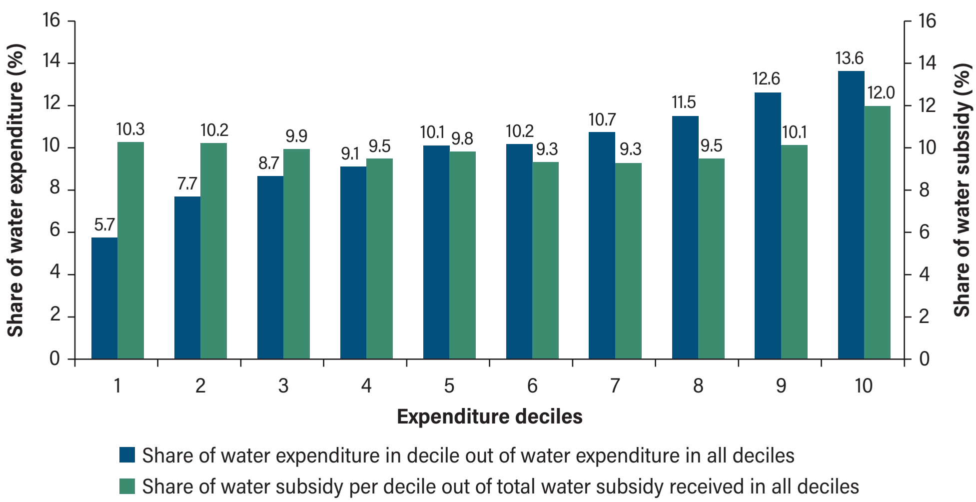
Source: Authors' calculation using data from Consumer Expenditure Survey–POF 2017/18, and International Benchmarking Network (IBNET).
Note: Subsidy beneficiaries are households. All figures are calculated using sample weights. POF = Pesquisa de Orçamentos Familiares.

This is laudable, until one observes in the same figure that, reflecting Brazil's very high inclusion error rate—high especially for an upper middle-income country—the proportion of beneficiaries in each decile who receive piped water subsidies is actually higher in the upper deciles than in the lower deciles, and highest of all in the wealthiest 10 percent. Indeed, the proportion steadily increases the higher one goes up the deciles. Furthermore, between the bottommost and topmost decile, there is a huge gap—93 percent versus 71 percent—in the proportion of households who received water subsidies. This implies that the water consumption subsidies are regressive in Brazil.

SHARE OF WATER SUBSIDIES ACROSS EXPENDITURE DECILES

As shown in figure 3.4.8, similar to the findings above, the distribution of the amount of water consumption subsidies is quite even across the expenditure deciles. Although 10 percent of the amount of water consumption subsidies received nationally accrue to the bottommost decile, the topmost decile receive 2 percentage points more. On the other hand, with cars to wash, swimming pools to fill, and gardened landscapes to water, the topmost 10 percent of households use much more water than the bottom 10 percent—more than twice as much per household—and correspondingly pay that much more for water. That higher expenditure per household, however, most likely represents a much smaller share of their household income than the share of the bottom 10 percent's water expenditure represents of their income.

FIGURE 3.4.8 Share of Water Expenditure per Decile out of Water Expenditure in All Deciles; and Share of Water Subsidy per Decile out of Total Water Subsidy Received in All Deciles



Source: Authors' calculation using data from Consumer Expenditure Survey– Pesquisa de Orçamentos Familiares (POF) 2017/18, and IBNET.
Note: Subsidy beneficiaries are households. All figures are calculated using sample weights. Total expenditure is household expenditure in all categories.

The above analysis of piped water consumption subsidies in Brazil indicates two important points. First, despite the relatively equal distribution of subsidy beneficiaries across income deciles, there are a large number of households in the bottom deciles who are left out, for instance, only 71 and 79 percent of the households in the bottom two deciles respectively receive piped water consumption subsidies. Second, even though the richer sections are able to spend more on water, they receive a disproportionate share of the total amount of subsidies spent.

The likelihood of receiving water consumption subsidies is endogenous to, or a function of, the layout of an area's water network infrastructure.

Discussion: Some Thoughts on the Use of Benefit Incidence Analysis in Infrastructure Sectors?

Benefit incidence analysis is often used to assess the targeting performance of subsides in various sectors such as health, education and water supply and sanitation. This concluding section revisits benefit incidence analysis (BIA) to reflect on its potential limitations for infrastructure sectors such as water and sanitation. BIA is used to assess the distributional incidence of public expenditure—typically in social sectors such as healthcare, education or, for that matter, water and sanitation. BIA examines who benefits from public expenditure, and it pays particular attention to how those benefits are distributed among the various income groups or across locations. In other words, BIA is a lens for examining how effectively the government is targeting its resources toward "those who really need them," and whether subsidy programs can be better designed and targeted to the population for which the program was intended.

Yet in examining the distribution of consumption subsidies related to water services and networks, caution must be exercised in interpreting the results of a BIA. Infrastructure sectors such as piped or sewer networks are heavily capital-intensive, and once those capital investments have been made and the infrastructure constructed, the tendency is for the beneficiaries to continue receiving the benefits of the service, and that of any subsidies connected to it, as long as they remain connected to the network. In other words, once the infrastructure is in place—regardless of the political or historical reasons that led to its construction in the first place—there is a significant probability that path dependency will constrain, if not outright determine, who gets to connect to the services and who receives the water subsidies, because water subsidies for networked supply can be applied only where piped networks or other relevant network services and infrastructure are available. Because of this, the likelihood of receiving water consumption subsidies is endogenous to, or a function of, the layout of an area's water network infrastructure.

For instance, because of cost and financial viability considerations and often public health concerns due to population density, network infrastructure is more likely to be developed in urban areas. Moreover, larger cities and urban centers are frequently the seat of national or regional power—power that can be wielded to direct more government resources toward that area at the expense of other areas. This means that where piped water infrastructure is developed often depends on historical patterns of settlement, colonial rule, class status, and social segregation factors that may be based on income, caste, race, or color. That infrastructure, in turn, will determine, often for decades to come, who receives benefits and subsidies and who is excluded. These are the inclusionary and exclusionary factors that a BIA on its own is unlikely to capture or notice.

Take Dar es Salaam, for instance. The commercial capital and financial hub of Tanzania has a highly inequitable water and sewer infrastructure, whose deep-rooted access effects have been described as "hydraulic exclusion" (World Bank 2017, World Bank 2018). It is in many ways a legacy of the city's colonial past, when highly subsidized piped water connections were provided only to those areas of the city where the white ruling colonial class lived (World Bank 2018). The result is that, even today, despite significant urban sprawl, many of Dar es Salaam's residents, both the poor and the well-off, rely on mobile tanker trucks and small carts to provide them with daily drinking water (World Bank 2017). The layout of the city is an accident of circumstance, a historical curiosity, yet it has persistence power of path dependency and illustrates how patterns of inclusion and exclusion can be embedded in historical factors.

Water subsidies are in an important way different from a typical unemployment benefits program or, to offer a more recent example, a social assistance program for households during the COVID-19 pandemic. Both are more "universal" in that a beneficiary can claim them with a simple application as long as one meets the eligibility requirements such as age, health status, or income level. One is not likely to be excluded because of long-standing historical reasons or because of the neighborhood or section of the city in which one lives. The distribution of economic impact aid during a crisis does not require any infrastructure to be built, so the issue of uneven access to such infrastructure across socioeconomic groups and geographic boundaries does not arise.[9]

That is not the case with infrastructure-based subsidies such as piped water consumption subsidies, with their roots in the past as well in ownership of a physical asset such as a piped water connection, which would require high connection charges. As a result, the inequitable distributional incidence—or put another way, the regressivity—of water subsidies that can be observed in many countries (including many of those in this chapter's analysis) is often to a large degree an artifact of the, political and historical factors behind the development of the piped water infrastructure.

It should also be noted that, as countries move closer towards universal safely managed WSS services, the regressivity of the consumption subsidy distribution will begin to decrease. However, since being connected to the network is a prerequisite for such access, which often tends to be expensive for the poor, decisions on infrastructure placement and connection subsidies will play a major role in who receives access.

It is therefore important to go beyond benefit incidence analysis and situate it in historical context to fully understand why high rates of exclusion and/or inclusion errors may be prevalent in a particular country setting when analyzing the distribution of consumption subsidy.

Notes

1. See box 3.4.1 for a separate discussion on the relationship between per capita spending in the WSS subsector and access to safely managed WASH services in urban versus rural areas.
2. This section presents a summary of analyses carried out in past public expenditure reviews (PERs) and other studies to analyze the distributional incidence of public spending in the water sector on groups of beneficiaries.
3. These statistics are countrywide and outline the areas covered by each household survey, not only those served by utility companies.
4. This refers to the decile share of all households who are water subsidy beneficiaries.
5. For all countries, except Brazil, discussed in this chapter, welfare deciles were calculated using aggregate per capita consumption expenditure. For Brazil, welfare deciles were calculated using aggregate per capita income. In this chapter, we have used income and consumption expenditure interchangeably to refer to these welfare deciles and groups.
6. The analysis framework proposed in Angel-Urdinola and Wodon (2007) can be used because it allows for the estimation of benefit incidence among population groups (for example, poor versus nonpoor). The analytical framework proposed decomposes the calculated benefit incidence indicator into five factors that impact the efficiency of subsidy targeting: access, usage, targeting, rate of subsidization, and quantity consumed.
7. As shown in figure 3.4.7, the error of exclusion (EE) is the share of households in poverty that are not benefiting from the subsidy: $EE = 1 - (BP/P) = AP \times UP|A \times TP|U = (P - BP) / P$. The error of inclusion (EI) is the share of beneficiary households that are not in poverty: $EI = BNP / BH = BNP / (BP + BNP)$.
8. POF, the Brazilian Consumer Expenditure Survey, is a series of household surveys conducted by IBGE (Instituto Brasileiro de Geografia e Estatística) to investigate consumption and expenditure patterns within the Brazilian population. The 12-month survey has been conducted every 6 to 7 years, starting in 1988, and covers the entire national territory. Among other uses, POF data serve as an input for the construction of consumption baskets that are used to estimate IBGE consumer price indexes.
9. Although both of these benefits programs require prospective beneficiaries to file their income tax returns and have a bank account, the benefit incidence of both is relatively homogeneous across income groups—from the poorest to the well-off—compared to the benefit incidence of piped water networks spending.

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PART 4

PROGRESS NOT PERFECTION

Recommendations for Enhancing the Flow of Funds into Water

Tying it Together and the Way Forward

Overview

The water sector plays a central role in an economy to foster economic growth and human capital development, helping to reduce poverty for both current and future generations. Yet in nearly all its subsectors, the sector faces considerable challenges in broadening access and improving service quality primarily because of resource constraints, both natural and financial, and the rising opportunity costs of investment in the sector as new global priorities come into view, new groups contend for attention, and new crises soak up national fiscal capacity.

Further intensifying these challenges, the climate change goals that the world's governments set during COP26 have increased the investments required to improve climate adaptation and mitigation efforts in the sector. Building up the climate resilience of existing water infrastructure needs to be incorporated into the planning and design of new investments. The COVID pandemic and recent recessionary tensions around the world, coupled with a dramatic step-up in social sector spending, have also placed fresh pressure on governments' limited budgets, especially in low-income countries (LICs) and middle-income countries (MICs). As a result, many countries that previously were not, now are facing a debt crisis (Augustin et al. 2022; Kose et al. 2021a, 2021b).

The spending gap imperative. All these developments, taken together, make the challenge of bridging the financial gap in the water sector more pressing yet also more difficult to achieve. Against the backdrop of the ambitious goals national governments and international development community have set for the sector, the main policy imperative for the water sector now is to bridge its cavernous spending gap to achieve its sectoral goals in the near to medium term.

WSS and irrigation. The findings of this study demonstrate that the water supply and sanitation (WSS) and irrigation subsectors—two of the main water subsectors—will need to overcome significant financing shortfalls to achieve their respective targets (part 2 chapter 2). For example, to realize Sustainable Development Goals (SDG) 6.1 and 6.2, the WSS subsector faces an annual spending gap of $140.8 billion in 2017 prices. To meet even just the low-cost scenario—which involves subsidizing irrigation infrastructure only and reducing agricultural demand—the irrigation sector, worldwide, must find financing to close a spending gap of $3.5 billion a year.

The public sector's indispensable role. The public sector—the combination of government fiscal spending and state-owned enterprises (SOEs)—remains the water sector's primary source of both financing and funding.[1] About 92 percent of the total spending in the sector comes from public expenditure and SOEs (part 3 chapter 1). Given water's unique characteristics—its status as a public good, and the inherent social goals associated with its allocation and usage—the public sector's predominant role is unlikely to be displaced. Moreover, in the last decade or so, private sector investments in water have largely been marginal—1.7 percent of total annual spending in the sector (part 3 chapter 1). The question of how the substantial spending gap will therefore be bridged falls essentially on the public sector.

Considering the fiscal challenges most countries now face following the pandemic, urging governments to step up public financing of the water sector will not be easy. But in light of water's central role in the economy, the need to explore every realistic option to bridge the gap is an urgent one.

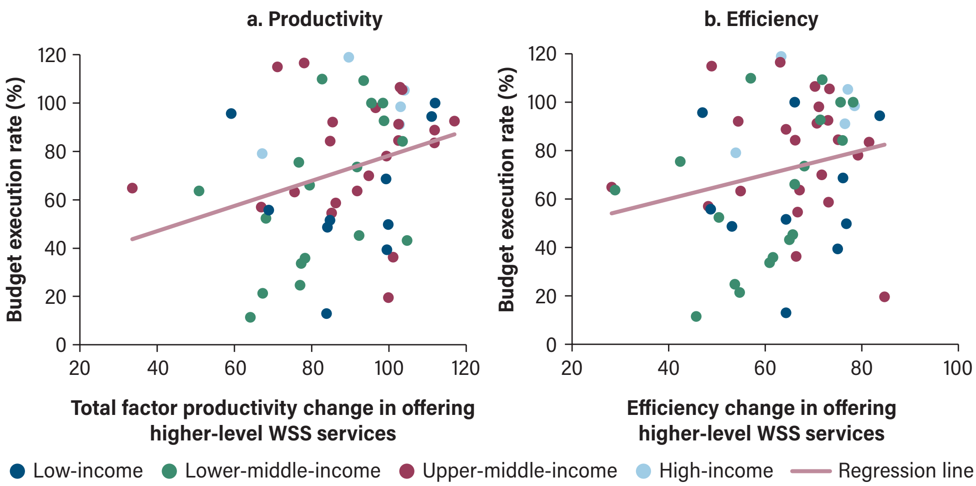
Raising budget execution rates. For one thing, governments can start by improving their budget execution rates for the water sector, which globally average about 72 percent (part 3 chapter 2)—meaning that about 28 percent of the budget that governments allocate to the water sector every year goes unspent. It is something of a paradox that, while the sector is experiencing severe shortfalls in financial resources, ministries, departments, and agencies are not able to fully use the budget that has already been made available to them. This improbable situation points to the pervasive and systemic issues that constrain the sector's absorptive capacity—issues primarily to do with institutional, governance, project management, and political economy factors, but not limited to them. Improving budget execution may help bridge the spending shortfall in the sector. It is estimated that reducing the budget execution gap by 50 percent will reduce the annual spending shortfall by about $13 billion.

Enhancing productivity and efficiency. Another option for bridging the water sector's yawning spending gap is to improve the productivity of public spending and reduce the pervasive inefficiencies that have traditionally encumbered the water utilities (part 3 chapter 3). For more than a decade, water sector public spending has faced declining total factor productivity (5–6 percent),[2] stemming mainly from efficiency losses. As discussed in part 3 chapter 3, only 35 percent of the utilities found in the International Benchmarking Network (IBNET) database are able to cover their operations and maintenance (O&M) costs of service provision and 14 percent of the total economic cost, that is, O&M and future capital costs.

Additionally, during the period 2004 to 2017, this study found that the median cost efficiency of water utilities was only 86 percent. Their median technical efficiency was lower still—63 percent, meaning that the same level of WSS services could be supplied with about two-thirds of the inputs currently used. Therefore, simply increasing spending increasing spending in the water sector, desirable as that would be, will therefore not be enough. Progress toward achieving the sector's SDG targets will also need to be accompanied by higher levels of productivity and efficiency. As the scatterplot in figure 4.1 shows, productivity and efficiency are positively correlated with budget execution, indicating that the challenge of bridging the sector's financing gap is more systemic, interrelated, and not restricted to the sheer availability of finances.[3] Improving productivity and efficiency in the sector would not only enhance the execution of existing budget allocations but also attract additional financing—from the government, the private sector, and other sources.

Improving equity. Finally, the sector's SDG targets stress the urgency to extend higher-level services to underserved communities, including those in difficult-to-reach areas such as dense urban districts or remote rural regions—often referred to as "the last mile" of service delivery. It is imperative that allocating more funds to the sector, as important a goal as that is, is coupled with a commitment to spending and investing those funds equitably (part 3 chapter 4). In the vast majority of developing nations in the Global South, marginalized communities in impoverished or remote areas struggle to subsist with little to no access to even basic water and sanitation services (WHO and UNICEF 2021, 2023). This underscores the need for a rigorous, fair-minded, and disciplined approach to expenditures that strategically addresses the persistent disparities ingrained in the sector.

FIGURE 4.1 Productivity and Efficiency: Budget Execution Rates in the WSS Subsector



Note: Budget execution vs. spending gap (*N* = 52 countries, 10 low-income, 20 lower-middle-income, and 22 upper-middle-income). No high-income countries. Correlation coefficient (budget execution, productivity) = 0.3058; Correlation coefficient (budget execution, efficiency) = 0.2219. WSS = water supply and sanitation.

Bridging the Financing Gap

THE FUNDING–FINANCING DISTINCTION

Mobilizing resources for infrastructure investments has two major stages, each defined by a specific challenge: (i) who pays for the upfront costs at the start of the project, and (ii) who eventually bears the cost of expenditures. This, in essence, is the distinction between financing (which occurs before the project) and funding (which occurs well after the project is under way). Let us look at funding first.

Funding refers to the money or resources that come from the entity that ultimately bears the cost of the investment expenditure. On one extreme, the entire expenditure is borne by the direct beneficiaries, who are charged full cost-recovery prices in the form of user fees or tariffs. On the other end, the entire cost of the expenditure is borne by the society regardless of whether they are the direct beneficiaries of the service. In this case, the government covers the cost using tax revenue. Funding is a cash flow issue and, for a major infrastructure project such as piped water or sewer network, can take years or decades to accrue. It is often a long-term process.

Financing, on the other hand, is a shorter-term mechanism by which the equivalent of this potential accumulated cash flow is made available upfront to construct the infrastructure project so it can start providing services. It includes the complex arrangements and procedures used in performing the investment operation—the various agents involved, the instruments employed, and their specific characteristics such as maturity, cost, and repayment rules (Fay, Martimort, and Straub 2021). The particular combination of elements depends on the particular country's regulatory and political environment, and the social and political agenda it is pursuing. In some cases, especially when domestic sources of financing are limited, governments can leverage financing from external sources in the form of official development assistance (ODA)— transfers from development partners and international organizations (part 3 chapter 1).

THE LIMITS OF TARIFF REFORM AND EFFICIENCY IMPROVEMENTS

Financing is a shorter-term mechanism by which the equivalent of this potential accumulated cash flow is made available upfront to construct the infrastructure project so it can start providing services.

Direct and indirect costs. In most countries, a mix of tariffs, taxes, and transfers are used for financing infrastructure. Because pricing is often considered the most effective instrument to attain the efficient use of water resources, tariff design is critical from the perspective of cost recovery and ensuring efficiency in the use of scarce water. The water sector is often criticized for having tariffs well below cost recovery prices. Economic efficiency requires that all water users pay a fair fee that adequately reflects both the direct and indirect costs of water use. The direct cost of water use comes from the fixed and operational costs of providing water (drinking water to households or irrigation water to croplands, for example). Indirect costs come from the negative externalities users may inadvertently impose on others, for example, by reducing the quantity of their water supply or affecting its quality. Calculating the full direct and indirect costs is therefore a demanding exercise because indirect costs such as externalities are often concealed or lie in the future. Adding to this, markets do not exist for the environmental uses of water, and property rights for water are poorly defined. Because of this, water typically remains underpriced in most economies (see box 4.1).

Markets do not exist for the environmental uses of water, and property rights for water are poorly defined. Because of this, water typically remains underpriced in most economies.

The tension between financial viability and inclusion. Moreover, in countries where broad inclusion is a genuine political goal—perhaps because a substantial portion of the population are poor—the government often is unwilling to achieve full cost recovery by charging higher tariffs because of concerns about excluding those who cannot afford to pay. Indeed, in certain subsectors like sanitation, trying to achieve cost recovery through user fees alone is often ineffective for two reasons: one, because many beneficiaries are unwilling to connect and pay for something they feel should be free (Coville et al. 2020) and, two, because services like sanitation generate numerous positive externalities for society—meaning that, like vaccinations or primary education, they have positive spillover effects (such as disease prevention) that end up benefiting everyone, including those who did not pay for it. Because of those externalities, governments realize that the costs of the service should be borne more broadly than by just its direct paying users.

The issues of cost recovery and affordability must be addressed separately and transparently because the divergent policy objectives of full cost recovery and affordability usually cannot be met with a single policy instrument of water tariffs.

As in nearly all other infrastructure sectors, one of the main difficulties in water sector financing therefore is managing the tension between financial viability and inclusion. Yet unless tariffs are set at the level of full cost recovery, service providers will face commercial losses, which in turn will affect the quality of the service, inhibit upgrades, and limit expansion of coverage. To prevent service providers from facing unsustainable costs, governments therefore often provide budgetary support.

Reducing inefficiencies by 75 percent would bridge only a small portion (12.3 percent) of the gap between an average cost-reflective tariff and the average actual tariff.

The downside is that such support sometimes leads to excessively “soft budget constraints” where the government goes too easy on the service providers. In the process of trying to help, the government inadvertently creates moral hazard conditions that distort the service providers’ incentives, making them come to feel that, even if they underperform or experience financial distress, the government will always be there to bail them out (Fay and Straub 2017; Kornai, Maskin, and Roland 2003). When this happens, it tends to perpetuate an endless cycle of low-cost recovery, poor financial performance, and lower service access and quality, which feeds back into low cost recovery. As postulated by Tinbergen (1952), the issues of cost recovery and affordability must be addressed separately and transparently because the divergent policy objectives of full cost recovery and affordability usually cannot be met with a single policy instrument of water tariffs (Andrés et al. 2021; Tinbergen 1952).

Inefficiencies play a minor role. It is generally argued that water utilities can reduce their spending gaps by reducing their inefficiencies on various fronts. These include (i) low levels of bill collection, (ii) non-revenue water[4], (iii) bloated staffs, and (iv) CAPEX (capital expenditure) inefficiencies. Using IBNET data, box 4.1 presents an analysis that simulates the potential reduction in the gap between an average tariff and a fully cost-reflective tariff due to the reduction of the kinds of inefficiencies just discussed. The analysis shows that reducing inefficiencies by 75 percent would bridge only a small portion (12.3 percent) of the gap between an average cost-reflective tariff and the average actual tariff. This points to the fact that to achieve full cost recovery, water utilities would need to increase their water tariffs severalfold (see box 4.1).

In South Asia, for instance, the gap that remains after addressing inefficiencies—$0.56—can be closed only by increasing the average tariff more than threefold. In Sub-Saharan Africa, the corresponding gap can be bridged only by increasing the average tariff by about 2.75 times. Clearly, other alternatives need to be explored considering the affordability issues faced by low-income residents in much of the Global South, along with the political infeasibility of such a radical tariff reform.

BOX 4.1 Achieving Cost Recovery through Efficiency Improvements and a Tariff Increase: A Simulation

Globally, water tariffs are too low in most economies. As discussed in this chapter, this is often driven by unavoidable tradeoffs between market efficiency and affordability, with politicians preferring to prioritize the latter for fear of social unrest. But in the absence of cost-reflective or full-cost recovery tariffs, service providers are bound to face losses and, ultimately, financial distress. So affordability cannot be rigidly pursued in isolation from commercial realities without eventual grave results.

Based on data available from the International Benchmarking Network (IBNET) it is estimated that, on average, water utilities charge roughly $0.90/m^3 for water (table B4.1.1, **column E**). The average tariff charged to consumers varies by region, from roughly $0.18/m^3 in South Asia (SA) to as high as $1.26/m^3 in East Asia and Pacific (EAP)—a sevenfold difference.

Aside from the EAP region, water utilities elsewhere generally charge consumers less than the cost-reflective tariff. The cost-reflective tariff estimated in **column F** represents a break-even point, the price water utilities would need to charge to cover both CAPEX and OPEX (operational expenditures). By contrast, the actual tariff charged by water utilities on average covers only about 46 percent of the fully cost-reflective tariff.

The respective average tariffs charged by utilities in SA, Latin America and the Caribbean (LAC), and the Middle East and North Africa (MENA) cover even less—not even a third of the cost-reflective tariff.

Reducing inefficiencies. First, we explore the reduction of inefficiencies as a method for closing the gap. **Columns A through D** present the savings that could be achieved by reducing inefficiencies across four areas. For example, a 75 percent reduction in overstaffing could, on average, result in a $0.024/m^3 saving **(column C)**. Regionally, MENA water utilities, followed by those in Sub-Saharan Africa (SSA), stand to benefit the most from cutting overstaffing inefficiencies, suggesting that water utilities in both regions face labor productivity issues. The greatest savings can be attained by reducing CAPEX inefficiencies. On average, a 75 percent reduction in CAPEX inefficiencies could result in a $0.114/m^3 saving, with MENA and Europe and Central Asia (ECA) water utilities standing to benefit the most **(column D)**. The large potential gains from the reduction of CAPEX inefficiencies are not surprising, given the capital-intensive nature of networked WSS services, particularly in MENA and ECA.

On average, the savings from reducing all inefficiencies—overstaffing, CapEx, and proportionate improvements in bill collection and non-revenue water—could yield an estimated total CAPEX of $0.15/m^3 for water utilities, about 14.06 percent of the cost-reflective tariff gap. Regionally, as a share of the cost-reflective tariff gap, water utilities in ECA and SSA would benefit the most from this overall inefficiency improvement.

As can be seen, however, a substantial gap still remains, so other options need to be explored.

Raising tariffs. To close the remaining 85 percent of the gap between actual tariffs and fully cost-reflective tariffs, water utilities will need to substantially increase their tariffs **(column K).** On average,

box continues next page

BOX 4.1 Achieving Cost Recovery through Efficiency Improvements and a Tariff Increase: A Simulation (*Continued*)

they must raise the actual tariffs they charge by an average of 101.22 percent—from \$0.90/m^3 to \$1.81/m^3. Utilities in MENA, LAC, and SA, however, need a more than 200 percent increase.

This simulation again highlights the difficult tradeoffs between price efficiency, commercial viability, and consumer affordability that governments and water utilities must negotiate with the societies they serve.

TABLE B4.1.1 Closing the Tariff Gap by Reducing Inefficiencies and Raising Tariffs (\$/m^3)

Regions	Savings from a 75 percent reduction in inefficiencies (\$/m^3)				
	Bill collection non-technical inefficiencies	Non-revenue water non-technical inefficiencies	Overstaffing inefficiencies	CAPEX inefficiencies	Average tariff
	(A)	(B)	(C)	(D)	(E)
SA	\$0.002	\$0.002	\$0.022	\$0.027	\$0.18
ECA	\$0.005	\$0.005	\$0.039	\$0.186	\$0.75
EAP	\$0.002	\$0.002	\$0.004	\$0.025	\$1.26
LAC	\$0.009	\$0.009	\$0.019	\$0.162	\$0.84
MENA	\$0.002	\$0.002	\$0.067	\$0.027	\$0.31
SSA	\$0.016	\$0.016	\$0.052	\$0.248	\$0.79
World	\$0.006	\$0.006	\$0.024	\$0.114	\$0.90

Regions	Cost-reflective tariff	Cost-reflective tariff gap	Total savings from inefficiency reduction (A + B + C + D)	Savings as a share of cost-reflective tariff gap ((H/G) *100%)	Remaining tariff gap after inefficiency reduction (G-H)	Remaining tariff gap as a share of average tariff ((J/E) *100%)
	(F)	(G)	(H)	(I)	(J)	(K)
SA	\$0.62	\$0.43	\$0.05	12.67%	\$0.38	208.61%
ECA	\$1.79	\$1.04	\$0.23	22.51%	\$0.81	107.45%
EAP	\$1.08		\$0.03			
LAC	\$2.96	\$2.11	\$0.20	9.42%	\$1.91	227.53%
MENA	\$1.16	\$0.84	\$0.10	11.75%	\$0.74	239.13%
SSA	\$2.51	\$1.72	\$0.33	19.32%	\$1.39	175.66%
World	\$1.96	\$1.06	\$0.15	14.06%	\$0.91	101.22%

Source: Data from IBNET covering 1,549 water utilities in 91 countries.
Note: CAPEX = capital expenditure; EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa.

FINANCING CHALLENGE AND THE EMERGING PRIVATE SECTOR

An unrealized vision. In the late 1980s and 1990s, the underlying thinking in policy circles was that, if developing countries followed the pro-market reforms—in particular, privatization, trade liberalization, fiscal prudence, and other market-friendly reforms—then, as classical economic theory predicts, capital would begin to flow from high-income countries that have a lot of capital to low-income countries. The argument was that differences in capital-to-labor ratios, demographic advantage, and profitability between high- and low-income countries, along with diminishing returns to capital in the high-income countries, would favor developing countries that followed the prescribed reforms, which in turn would boost infrastructure investment and growth in such countries (Estache and Fay 2007).

This was indeed the thinking behind the faith many placed on foreign direct investment (FDI), mainly from the private sector, into infrastructural sectors in the developing countries.[5] But as the Lucas Paradox[6] (Lucas 1990) pointed out, increased capital such as ODA and FDI did not flow from the developed to the developing countries as expected because of a range of structural and political economy factors, from differences in human capital and skill levels to institutional and regulatory bottlenecks (Henry and Gardner 2019).

In Part 3 chapter 1, this study also shows that, over the past three decades, ODA flows from Development Assistance Committee (DAC) countries, multilateral lenders, and bilateral lenders, taken together, have been relatively stable. Not only have they not increased but they have constituted only a small proportion of the total expenditure in developing-country infrastructure sectors, including water.

Unfulfilled private capital expectations. Similarly, despite the large amount of private capital that could be channeled into infrastructure investments in developing countries (Collier and Cust 2015), such optimistic expectations have not to date materialized for the water sector. It has been estimated that, globally, assets under management (AuM) will almost double by 2025—from $84.9 trillion in 2016 to $145.4 trillion by 2025 (PwC 2017). Yet as discussed in part 3 chapter 1, the role of the private sector in the water sector has been marginal, constituting only about 1.7 percent of the spending in the sector in 2017.

Although some regions are doing somewhat better—LAC's water sector receives the most private sector investments—even in those cases, data from the World Bank's Private Participation in Infrastructure (PPI) database show that about a third of PPP investments come from public sources (such as debt), and about half of this one-third, or one-sixth of total PPP investments, come with some form of government guarantee. For the foreseeable future, the PPP share in total water infrastructure spending, and in the WSS subsector, is unlikely to increase significantly.

Overoptimism. The at times unwarranted optimism in certain developing countries about dramatic private sector flows into the water sector perhaps stems from an unwillingness among policymakers to acknowledge that, unlike the multilateral agency community, the international private sector is driven primarily by a profit motive based as much on instinctive "animal spirits" (Keynes 1936) as on rational calculation. And rational calculation—in the form of political risk assessments, concerns about demand and cost recovery due to in-country regulatory controls including low and rather inflexible tariffs, and shrewd comparative analyses of alternate investment options elsewhere—has not yet driven private investment inflows into the water sectors of developing countries.

A need for realignment. Policymakers and other stakeholders need to draw up a revised role or vision for PPPs in the water sector that better leverages and aligns the comparative strengths, advantages, and expectations of that particular prospective PPP with the needs of that particular water sector, and the political economy in which it functions. Decades of experience demonstrate that the success of PPPs in the water sector is significantly context-specific and depends heavily on the political, institutional, and regulatory environment governing water in that country, together with the maturity of the domestic private sector.

Areas of opportunity. There are several niche areas in the water sector where the private sector can actively leverage its technological and project management know-how. The private sector can play a premiere role in downstream activities such as fecal sludge management, wastewater treatment and reuse infrastructure, and maintenance of WSS systems, while introducing new innovation in the sector. A good example of this is Singapore's NEWater wastewater reclamation project. Launched in 2003 to reduce the country's dependence on water imported from Malaysia,[7] it uses advanced membrane microfiltration, reverse osmosis, and ultraviolet irradiation disinfection technologies to treat wastewater to produce high-quality water that meets the World Health Organization's standards for drinkable water.

Two of Singapore's four NEWater reclamation plants, which currently generate 30 percent of all the water used in the country, were developed using a PPP model and private financing through Design-Build-Own-Operate (DBOO) concession contracts (World Bank 2018). The NEWater project serves as a prime example of how the private sector can engage in specialized areas within the water industry. Other potential opportunities include water conservation, particularly in reducing leakages and improving energy efficiency. These initiatives can be facilitated through performance-based contracts and supported by innovative hybrid public-private financing models.

Additionally, the private sector could explore viability gap funding (VGF) and credit enhancements such as partial credit guarantees (Bender 2017; Schur 2016). VGFs are a form of subsidy, often found in PPPs, that is used to cover cash shortfalls that occur during a portion of the financing term. Partial credit guarantees are a type of credit enhancement guarantee issued by the government, or sometimes a development finance institution or an insurance company, when the borrower is not attractive enough as a candidate for a conventional loan, to help establish commercial financing. As the borrower establishes its creditworthiness and commercial lending in the sector increases, the guarantors can gradually decrease their level of guarantee from full, to partial, and eventually to none.

Above all, however, as discussed in preceding sections, a more systemic and sector-wide approach toward improving productivity and efficiency in the water sector is the most important and fundamental prerequisite for attracting private finance.

Making Public Spending Work Better in the Water Sector

The foregoing analysis of the difficulty of attracting private finance reaffirms the central role of public spending in the water sector and the difficulty of cost recovery. As discussed in earlier chapters, increasing the magnitude of public spending, both absolutely and relative to other sectors, remains a challenge. With rising food prices and looming public debt, governments in every region are facing significant fiscal stress, and competing demands for public funds from other sectors such as social protection abound.

A more systemic and sector-wide approach toward improving productivity and efficiency in the water sector is the most important and fundamental prerequisite for attracting private finance.

It is not all just about increasing spending volumes, however. The link between public spending and development outcomes depends heavily on the quality and efficiency of the public investment. Public spending does not necessarily translate into creating productive capital stock because it can be influenced by misaligned political motives and corruption (Aschauer 1989; Pritchett 2000). For example, Henisz et al. (2006) have shown that political pressure exerted by interest groups and the structure of political institutions can affect investments made by state-owned electric utilities. It is therefore essential to look more closely at how public expenditure can be used most efficiently and effectively to maximize its social benefits.

Therefore, to enhance the effectiveness of financial resources in the water sector, two aspects require emphasizing: (1) The need to improve the utilization and efficiency of available public funds, and (2) the importance of catalyzing additional financial resources through a judicious mix of reforms and the strategic use of public spending. The rest of the chapter sets out several policy reform possibilities for achieving these two objectives.

IMPROVING UTILIZATION AND EFFICIENCY OF PUBLIC SPENDING

Improving Public Investment Management

One of the main challenges the water sector faces is its low budget execution rate, compared to the human development sector and nearly every other infrastructure sectors (part 3 chapter 2). This paradox of the coexistence of funding gaps together with a failure to use all the available funding points to the sector's low absorptive capacity. Improving public investment management (PIM) by streamlining decision-making at all levels of the investment process[8] could go a long way to addressing the sector's low execution rate.

In many developing countries, the different stages of an infrastructure project's life cycle—from conceptualization and planning, to design, and implementation—are often affected by convoluted bureaucratic requirements and complex administrative systems, which in turn can affect the success of the project (Chakraborty and Dabla-Norris 2011). For example, it has been observed that large cost overruns, benefit shortfalls, waste, and low completion rates are common in major water sector infrastructure projects because of poor project selection, inadequate monitoring, and incomplete or inaccurate evaluation (Esfahani and Ramírez 2003; Flyvbjerg, Bruzelius, and Rothengatter 2003). Additionally, procurement delays caused in part by the existence of multiple approval and verification procedures act as a bottleneck that slows down the implementation of water projects. The conceptualization, planning, and design stages of water sector projects therefore need particular attention because a poorly planned and designed investment program is almost certain to incur implementation challenges. In the post-construction phase, reforms should focus on managing the incentives of water utility managers to induce them to make appropriate decisions that are not swayed by distorted incentives created by soft budget arrangements or backroom corruption (Fay and Straub 2017).

Improving public investment management by streamlining decision-making at all levels of the investment process could go a long way to addressing the sector's low execution rate.

Reforming Public Financial Management

The public financial management (PFM)[9] system facilitates the flow of public funds within and across the government—from the Finance Ministry to the line ministries, departments, and implementing agencies. In many countries, the mandate to provide water and sanitation services lies with the subnational governments, which rely heavily on budgetary transfers from the federal or provincial governments. Yet at the same time, they typically have limited capacity to prepare project plans and budget proposals or to implement projects on an annual or medium-term basis. This limitation, in return, affects their ability to receive resources from the higher-tier governments.

Furthermore, studies in the water and other infrastructure sectors have revealed that funds flow from the higher levels of government as well as donor funds are unreliable, unpredictable, and often delayed—all of which contribute to service delivery challenges on the ground. Such unpredictability and delays ultimately undermine the efficiency of budgetary execution. Anecdotal evidence indicates that a main reason for the water sector's low execution rates is the lack of predictability of funds and chronic delays (OECD 2009). Thus, considering that water sector investments are typically long term, there is a need for better medium- to longer-term budget planning for the sector, with a focus on multi-year programs.

This should also include maintenance planning. In the absence of proper planning and budgeting, maintenance becomes an after-thought that often gets relegated to the bare essentials, thus affecting the long-term sustainability and life span of infrastructure. An important reform is to build a culture of consistent and systematic maintenance.

All these are possible only if a proper monitoring system is put in place. In order to achieve this, at the programmatic, economic and functional levels, fund flows need to be tracked promptly, meticulously, and accurately to grasp how the funds are ultimately being deployed, and by whom.

Developing a Realistic Metric of the Performance of Public Entities and SOEs

Public entities and SOEs continue to dominate service provision in infrastructure sectors, including water. As earlier mentioned, the private sector is often unwilling to bear the risks associated with providing public goods like water partly because of the need to balance the tradeoffs between efficiency and equity. Consequently, public entities and SOE service providers are compelled to charge prices below actual cost and to extend services to commercially unprofitable areas to maximize social welfare. Often, public entities are also mandated with additional development objectives, such as generating employment and expanding access, which leads to a further disregard for profitability considerations. Thus, in this context, it is important to develop a realistic metric of the performance for public service provision because it goes well beyond operational efficiency considerations alone (Vagliasindi, Cordella and Clifton 2021).

CATALYZING THE FLOW OF LONG-TERM FINANCING INTO THE WATER SECTOR

Developing A Credible Regulatory System to Facilitate Risk Pooling and Long-Term Financing

As discussed earlier, water sector investments are typically capital-intensive and long-term. This magnifies the sector's funding and financing challenges, which makes it all the more important for the water sector to operate within a robust institutional and regulatory environment. For example, it has been found in Latin America that, in contexts characterized by weak governance and political opportunism, a sound institutional and regulatory framework is exceptionally important (Guasch, Laffont, and Straub 2007) because it significantly influences the sector's performance. In the absence of periodic tariff revisions based on established principles of affordability and cost recovery, as well as a credible regulatory environment and institutions to achieve such, service providers tend to make huge losses, forcing them to rely on governmental transfers.

An important reform is to build a culture of consistent and systematic maintenance.

In contrast, if a credible regulatory system exists that determines tariffs and service standards regardless of political expediency, then risk-pooling arrangements can be designed for water utilities as a group, with support from the government and the private sector, rather than individually, to enable them to engage in long-term borrowing from the financial markets. For instance, smaller utilities with varying performance and risk levels could be aggregated, either administratively or financially, to facilitate borrowing from the financial markets, with additional assistance provided by government guarantees or multilateral organizations.

Developing special purpose financial institutions. Furthermore, because improving access and the quality of services in the SDG era call for a substantial increase in capital investments in the sector, special purpose financial institutions at the national and subnational levels must be developed with an exclusive focus on channeling long-term finances into water and other infrastructure investments.[10] In conjunction with well-resourced, independent, and transparent regulatory institutions, public and donor funds can be used as guarantees to reduce the various types of risks associated with such investments, regardless of the service provider's ownership structure.

Promoting regulatory autonomy. Recent research on water and sanitation service providers suggests that, if there is an independent regulator and associated institutional and regulatory reforms, then ownership structure—public, private, or joint—does not matter in determining performance, both in the efficiency and the social dimensions (equity, access, and affordability) (Bagnoli et al. 2023; Tzoumis, Stutsman, and Bennett 2016). This could open the door for multilateral development organizations, and development finance institutions to work more closely with national governments and local authorities to support investment in regulatory reform and to catalyze greater private finance flows into the water sector.

REFORMING THE WATER SECTOR FOR MORE AND BETTER PUBLIC SPENDING

Cost Recovery and Demand Management

Cost recovery is a perennial challenge for water service providers. Identifying which costs to recover (O&M or capital costs or both, for instance) and how (through tariffs, through transfers, or a combination) will depend on the political priorities and institutional environment in which the sector operates. There is no one-size-fits-all solution for all contexts. For example, in addition to focusing on tariff levels alone, timely maintenance and the efficient use of inputs such as energy in a sector as energy intensive as water can significantly reduce costs. It is estimated that about 4 percent of global electricity consumption was used to extract, distribute and treat water and wastewater (IEA 2017). Also, with the limited resource availability and imprecise design capacity that many urban utilities face, demand management measures—through a combination of pricing schemes and behavior change initiatives—could help reduce costs in the short to medium term (Costa and Gerard 2021).

Recent research on water and sanitation service providers suggests that, if there is an independent regulator and associated institutional and regulatory reforms, then ownership structure—public, private, or joint—does not matter in determining performance.

Improving State Capacity and Human Resources

The ability of the state to realize its intended policy goals lies at the heart of state capacity. State capacity includes the institutional environment that facilitates or impedes market transactions, property rights preservation, and public goods provision (Andrews, Pritchett, and Woolcock 2017), along with the bureaucracy's capacity, skills, and motivation to undertake their assigned functions to improve the provision of public goods and services. Many of the service delivery challenges faced by economic sectors such as water result from limited state capacity.

Additionally, many proposed reforms, including tariff revisions, encounter political contestation because of the public's low trust and the low perceived legitimacy that saddle many governments and service providers, often stemming from a track record of poor service delivery and poor communication (Andrés et al. 2019). To improve the effectiveness of public spending in the water sector and subsectors, consistent and long-term improvement in state capacity has to be achieved through institutional and policy reforms as well as through targeted capacity-building initiatives. These might include support for the professionalization of service delivery through improvements in operational performance, and the development of investment and business plans to support service providers' access to domestic and international commercial finance.

Disaggregated data on public financial flows in the water sector are hard to come by.

Improving Data Access, Transparency, and Communication

Disaggregated data on public financial flows in the water sector are hard to come by Since the water sector typically extends across multiple ministries and agencies, it is in practice difficult to reach a comprehensive understanding of public spending in the sector across various institutions without proper data systems. Publicly accessible budget data are often available in an aggregate form but are often riddled with inaccuracies and incompatibilities. There is an urgent need to improve the quality and transparency of both on-budget and off-budget expenditure data in the water sector. The data also need to be comprehensive enough that they can be used to assess the credibility, reliability, and timeliness of the flows of funds at all levels in relation to planned, time-bound, sector targets. Transparent access to sector-level public spending data and public expenditure tracking surveys (PETS) in selected countries would likely improve accountability and service delivery in the water sector.

Closing Remarks

In conclusion, the water sector's role in driving economic growth, promoting human well-being, and sustaining the ecosystem is overriding in its importance. However, a nexus of challenges, from resource constraints to rising opportunity costs, from weak institutional capacity to the escalating impacts of climate change, have created uncertainties about its potential and ability to realize its globally established targets.

Yet the convergence of the COVID-19 pandemic and the urgent need for climate adaptation in the context of significant sector challenges underscores the imperative to address the sector's financial shortfalls. With governments navigating the complexities of balancing burgeoning social expenditures with limited fiscal resources, bridging the water sector's funding and financing gaps looks increasingly formidable.

Amid these challenges, it behooves policymakers and other stakeholders to adopt a fresh approach that acknowledges the complex interdependence of countries through the shared water cycle, and therefore regards water as a global collective good (Mazzucato et al. 2023). A paradigm shift toward treating water as a global common good while recognizing the local rights in its ownership and use, would nevertheless necessitate a fundamental rethink of its economics. Like the alliance recently formed by Brazil, Indonesia, and the Democratic Republic of the Congo (DRC)—the three countries with the world's largest rainforests—to work together to manage and conserve their forests as a global public good that transcends their particular national interests,[11] reshaping water markets will require policymakers to begin to recognize water as an asset with multiple positive externalities that go beyond national boundaries, one that offers humans and businesses irreplaceable services and crucial capabilities. Such a paradigm shift would, therefore, acknowledge the intricate interdependence of countries through the shared water cycle.

Translating this re-lensing into practical steps would involve launching initiatives that embrace innovative public-private partnerships, property rights, and counter-rent-seeking mechanisms. The vision is that the effective management of water as a global common good should ultimately cascade into a global-scale effort, but it would need to start at the local level—with municipalities, governments, and regional blocs crafting goal-driven missions as a first step.

In time, as governments and international bodies strive to meet the SDG targets set for the sector, a multifaceted strategy would likely emerge as the way forward. Although the public sector will remain the anchor of funding, unlocking the water sector's potential will also require enhancing execution rates and addressing deep-rooted technical, cost, and institutional inefficiencies. The effectiveness of public investment hinges on its quality and efficiency, which in turn are influenced—indeed, determined—by the underlying political economy and regulatory environment. As documented thoroughly in this study, the interconnectedness of budget execution, productivity, and efficiency underscores the comprehensive nature of overcoming the financing challenge and the need to adopt a multipronged approach. There is no single silver bullet. Additionally, the need to achieve equitable and universal access to safely managed water and sanitation services, even in remote areas—encoded in the SDG 6.1 and 6.2 targets—will call for investing judiciously so that national resources can be apportioned optimally.

Reshaping water markets will require policymakers to begin to recognize water as an asset with multiple positive externalities that go beyond national boundaries.

Increasing the sector's financial resources will entail directing attention to two aspects of public spending: (i) improving utilization and efficiency, and (ii) catalyzing additional resources through reforms and prudent spending. Improving utilization and efficiency involves enhancing public investment management by streamlining decision-making and addressing bureaucratic inefficiencies that impede budget execution and the sector's overall absorptive capacity. It also calls for reforms in public financial management systems to ensure reliable, predictable fund flows, particularly at subnational levels. Further, with the prominent role publicly owned service providers and SOEs play in the water sector's development, it is important to design a realistic metric of performance for them, one that reflects both operational efficiency and the country's broader development and social equity objectives.

On the other hand, the second—catalyzing long-term financing through reforms and prudent spending—demands a credible regulatory framework to enable risk pooling, to facilitate timely tariff revisions, and to attract investment. A sound, independent regulatory environment that is insulated from undue political influence would help ensure tariff stability and almost certainly encourage private sector participation. Additionally, special-purpose financial institutions need to be developed to channel long-term financing into water and infrastructure projects, backed by guarantees from public and/or donor funds to mitigate risks. In short, the water sector should be reformed to optimize public spending, focusing on cost recovery, demand management, state capacity improvement, and data transparency.

The path to sustainable development in the water sector hinges on a collaborative and strategic approach, underpinned by financial prudence and innovation. By reimagining water not just as a resource, but as a vital global asset necessitating careful stewardship, we can move towards bridging the sector's financial gap. As countries and the international development community navigate these challenges, our collective resolve and commitment will be instrumental in safeguarding this essential resource – the basis of all life on our planet – for both present and future generations, ultimately contributing to a more prosperous and livable world.

Notes

1. For the difference between financing and funding, see the subsection further below, "The Funding–Financing Distinction."
2. Total factor productivity declined by 5 percent for piped and sewer services and 6 percent for basic-level service provision.
3. These scatterplots are simple illustrations of patterns that do not suggest any causality. Productivity, efficiency, and budget execution are all indeed endogenous and are affected by several other factors, including institutional and political characteristics.
4. Non-revenue water is water that is processed and pumped but gets lost and is never accounted for. It includes water that ends up not being billed because of metering inaccuracies or theft, and water that never reaches end users because of a transmission mains leakage or a broken pipe (real losses). Either way, it does not generate revenue for the utility.
5. See, for example, Woetzel et al. (2016).
6. The Lucas Paradox, named after economist Robert Lucas, refers to a situation in international finance and economics that contradicts theoretical expectations. The paradox is centered around capital flow between developed and developing countries. According to economic

theory, capital should flow from developed countries, where capital is abundant and therefore has a lower marginal product, to developing countries, where capital is scarce and has a higher marginal product. This movement would yield higher returns for investors and promote economic growth in poorer countries.

7. The government of Malaysia is bound by treaty to sell water to Singapore up until 2061 but is thereafter free to end that trading relationship, which many suspect it likely will.
8. The investment process involves (i) preparation and implementation of strategic guidance and project appraisal; (ii) project selection; (iii) project implementation; and (iv) project evaluation and audit.
9. "PFM in the narrowest, and perhaps most traditional, sense is concerned with how governments manage the budget in its established phases—formulation, approval, and execution. It deals with the set of processes and procedures that cover all aspects of expenditure management in government" (Cangiano, Curristine, and Lazare 2013, p. 999).
10. For example, the Kenya Pooled Water Fund was initiated to help mobilize domestic finance resources for water and sewerage infrastructure development in the country. It was established in 2017 with the support of the Netherlands Embassy in Nairobi, the Kenyan National Treasury, the Ministry of Water and Irrigation, the Water Sector Trust Fund, the United States Agency for International Development (USAID), Swedish International Development Cooperation Agency (SIDA) and Stichting Nederlandse Vrijwilligers (Netherlands Development Organization) (SNV) (USAID 2021).
11. At COP 26 in 2021, the governments of Indonesia, Brazil, and DRC launched a "Forest Power for Climate Actions" initiative, followed by high-level discussions at COP27 and at G20 meetings. The tripartite partnership has pledged to collaborate to support the sustainable management of their tropical forests as a global public good.

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Appendices

APPENDIX A

Estimating Infrastructure Capital Spending

"Replicating the "Hitting the Trillion Mark (2019)" with New Data"

Estimating infrastructure spending is often a complex exercise plagued by unreliable data that are not comparable across countries. Fay et al. (2019) is one of the most comprehensive attempts to estimate infrastructure capital investment at the global and regions levels. In order to estimate how much is spent by countries on infrastructure capital investment Fay et al. (2019) examined various methods and data sources, each with different sets of challenges (Box 2.1.1). The study estimates how much countries spend on capital investments in four infrastructure sectors—transport, energy, water and sewerage, and information and communication technology. Building on prior initiative undertaken by the Asian Development Bank (ADB) (2017), Fay et al. (2019) estimated the spending on infrastructure sectors using four datasets: (1) the national fiscal data or budget data of 55 countries available in the BOOST database as of 2019; (2) gross fixed capital formation in general government (GFCF_GG); (3) gross fixed capital formation in civil engineering works (GFCF_CE); and (4) public and private investment in infrastructure from the project level database put together by the World Bank. For descriptions of these datasets, see Box 2.1.1.

Fay et al. (2019) used these four datasets to calculate three alternative estimates of capital spending in infrastructure: (1) budgetary data from the BOOST dataset combined with private participation infrastructure investments (PPI); (2) GFCF_GG combined with PPI; and (3) GFCF of the whole public sector but including only civil engineering (GFCF_CE). These three data bases provide good coverage of Sub-Saharan Africa and Latin America, but representation of South Asia, Middle East and North Africa (MENA), and East Asia and Pacific (EAP) countries is relatively low (Figure B1.2.1.1 in part 2, chapter 1).

Strengths and weaknesses. Each of the three estimates has its advantages and drawbacks. In general, the BOOST+PPI estimates are typically lower-bound estimates compared with national accounts-based estimates, considering that SOE investments are not captured in the former. Since GFCF_CE includes other sectors beyond infrastructure, an assumed weight of 0.9 is applied to the GFCF_CE to arrive at an estimate of the share of infrastructure capital expenditure in the total capital expenditure across all sectors. This means that (0.9*) GFCF_CE is likely to be upper-bound estimates, except in countries where SOEs contribute a bigger share of public capital investment in infrastructure.

Our approach. This study, which closely follows Fay et al. (2019), first replicates each of the above estimates of infrastructure capital spending using updated data from all the sources. In their 2019 study, Fay et al. (2019) encountered a significant data limitation regarding the availability of the most recent BOOST and PPI data. This lack of data was particularly evident across numerous countries, resulting in the underrepresentation of certain regions in their analysis. By contrast, the estimates generated for this study use fiscal data from BOOST for 69 countries updated as of October 2021, and include government investment data up to 2017 for the International Monetary Fund's (IMF) GFCF_GG and the International Comparison Program's (ICP) GFCF_CE values. Fay et al. (2019), on the other hand, had data available for 55 countries in the BOOST database, and the GFCF and ICP's GFCF_CE data up until 2011. Moreover, the PPI database on private sector investment estimates has undergone significant revisions, including revisions to the estimates for the previous years. Finally, between 2011 and 2017, the values for gross GFCF_GG decreased. See table B.1 for a comparison of the input variables used in this study and in Fay et al. (2019).

The following equation was estimated based on a regression analysis over a sample of 69 countries with common coverage among the BOOST database (as of October 2021) and the two estimates of GFCF_GG and GFCF_CE and missing values for countries that are not covered by BOOST are predicted (Method 1).

Equation 1

$$Infras_{capex} = \alpha + \beta_1 * GG + \beta_2 * CE + \beta_3 * \log GDP + \beta_4 * Federal + \varepsilon$$

where $Infras_{capex}$ is the BOOST estimates of capital expenditure (excluding PPI), *GG* and *CE* are estimates from GFCF_GG (excluding PPI) and GFCF_CE, respectively, log GDP is the logarithm of current GDP in 2017, and the dummy variable *Federal* identifies whether or not a country has a federal government system. The detailed regression results are presented in table B.2. This approach allows us to predict infrastructure capital expenditure in 49 additional countries that are not covered by BOOST.

APPENDIX B

Estimating Water and WSS Capital Spending and Total Spending

With the same model specification of equation 1, this analysis takes a further step to estimate capital expenditure in the water sector wth the estimated infrastructure capital expenditure as an explanatory variable:

Equation 2

$$Water_{capex} = \alpha + \beta_0 * Infras_{capex} + \beta_1 * GG + \beta_2 * CE + \beta_3 * \log GDP + \beta_4 * Federal + \varepsilon$$

and then using water capital expenditure as an input to estimate total expenditure in the water sector:

Equation 3

$$Water_{tot\,exp} = \alpha + \beta_0 * Water_{capex} + \beta_1 * Federal + \beta_2 * X + \varepsilon$$

and covariates matrix X include country income classifications and geographical regions. With the input variable of water capital expenditure, we take the same approach to estimate capital expenditure and total expenditure in the water supply and sanitation (WSS) subsector:

Equation 4

$$WSS_{capex} = \alpha + \beta_0 * Water_{capex} + \beta_1 * GG + \beta_2 * CE + \beta_3 * \log GDP + \beta_4 * Federal + \varepsilon$$

and then using water capital expenditure as an input to estimate total expenditure in the water sector:

Equation 5

$$WSS_{tot\,exp} = \alpha + \beta_0 * WSS_{capex} + \beta_1 * Federal + \beta_2 * X + \varepsilon$$

Figure 2.1.1 in part 2, chapter 1 presents the process of this estimation approach. Based on the estimations of equations 1–5, levels of water total expenditure and water capital expenditure, WSS total expenditure and capital expenditure of 130 countries (including original BOOST countries) can be calculated by multiplying with current GDP in 2017. The total recurrent expenditure in the water and the WSS can also be calculated by subtracting capital expenditure from total expenditure both for water as an entire sector and for the WSS subsector, respectively.

The list of countries used for this analysis and detailed refinement and prediction results are reported in table G.1.

TABLE B.1 Comparison of Input Variables

Input variables for this study			Variables from Fay et al. (2019)		
Datasets	Mean	Obs.	Datasets	Mean	Obs.
Annual average BOOST (2009–20)	1.67	81	Annual average BOOST (2009–17)	1.73	55
GG (2017)	4.89	123	GG (2011)	6.27	118
CE (2017)	4.89	126	CE (2011)	4.59	120
Annualized PPI (2008–17)	0.49	92	Annualized PPI (2007–11)	0.94	105

Note: (1) The PPI database has undergone extensive revisions, affecting estimates for previous years. These changes primarily stem from significant alterations in the inclusion and exclusion of projects, alongside a marked reduction in the number of countries contributing data; (2) According to data from GG, there has been a notable shift in the share of GDP dedicated to this sector, moving from 5.2 percent in 2011 to 4.7 percent in 2017. This trend indicates a decrease, contrary to what might be inferred from the original figures. (3) The list of the most recent BOOST countries is provided for comparison. Compared with Fay et al. (2019), newly added BOOST countries are mainly in LAC, EAP, and MENA. GG = general government; CE = civil engineering; PPI = private participation infrastructure; MENA = Middle East and North Africa; EAP = East Asia and Pacific.

TABLE B.2 Ordinary Least Squared Regression Results

	(1) Infrastructure capital expenditure	(2) Water capital expenditure	(3) Water total expenditure	(4) WSS capital expenditure	(5) WSS total expenditure
Infrastructure capital expenditure		0.153*** [0.0271]			
Water capital expenditure			1.207*** [0.141]	0.705*** [0.0853]	
Water total spending					1.204*** [0.152]
GG	0.0548 [0.0351]	0.0222** [0.00987]		−0.0123 [0.0136]	
CE	0.0994** [0.0433]	−0.00797 [0.00548]		−0.00265 [0.00288]	
Log (GDP)	−0.376* [0.196]	0.0432 [0.0444]	−0.0181 [0.0479]	−0.00429 [0.0268]	0.0127 [0.0380]
Federal (=1 If federal government)	0.254 [0.455]	−0.0790 [0.0882]	−0.104 [0.0781]	−0.000504 [0.0374]	−0.107 [0.0689]
LowIncome (=1 if belongs to Lower or Lower middle income country group)			−0.0200 [0.0546]		−0.0282 [0.0468]

table continues next page

TABLE B.2 Ordinary Least Squared Regression Results ***(continued)***

	(1) Infrastructure capital expenditure	(2) Water capital expenditure	(3) Water total expenditure	(4) WSS capital expenditure	(5) WSS total expenditure
Regional dummies					
ECA (=1 if country in Europe and Central Asia region)			0.0297 [0.0679]		−0.00827 [0.0433]
LAC (=1 if country in Latin America and Caribbean region)			0.184* [0.101]		0.158* [0.0866]
SSA (=1 if country in Sub-Saharan Africa region)			−0.0139 [0.0605]		0.0233 [0.0324]
Constant	4.779** [2.041]	−0.503 [0.476]	0.272 [0.549]	0.122 [0.288]	−0.0783 [0.411]
R-squared	0.340	0.539	0.637	0.686	0.570
Obs.	69	63	74	59	71

Source: (1) BOOST: Annual average for 2009–20, from BOOST team, World Bank; (2) PPI: Annualized over 10 years from 2008 to 2017, from PPI Database, World Bank, https://ppi.worldbank.org/en/ppi; (3) GFCF_GG: 2017, from Investment and Capital Stock Dataset, IMF, https://infrastructuregovern.imf.org; (4) GFCF_CE: 2017, from ICP, World Bank; (5) Federal dummy from (Fay et al. 2019); (6) Income and regional group from World Bank classifications.
Note: (1) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ with robust standard errors; (2) Omitted regional group is a combination of EAP, SA and MENA countries. WSS = water supply and sanitation; GG = general government; CE = civil engineering; PPI = private participation infrastructure; GFCF = gross fixed capital formation; ICP = International Comparison Program; MENA = Middle East and North Africa; SA = South Asia; EAP = East Asia and Pacific.

APPENDIX C

Correlates of the Level of Public Spending

Aggregate Pubic Spending and Public Spending in Selected Sectors

We utilize sectoral expenditure data at the country level from the BOOST database, encompassing over 80 countries and spanning 12 years from 2009 to 2020. Notably, this database exhibits a considerable number of missing values in certain sectors, especially during the earlier years. If the missing data is not missing at random, it is likely that they are correlated with the error terms which has the potential to impact the reliability of our estimations. To construct a more balanced panel dataset, a linear interpolation technique is applied to fill the missing values by country. Seventeen countries did not have enough values to apply this interpolation technique. Descriptive statistics of the variables included in this analysis is provided in table C.1. All sectoral expenditure and GDP figures are in current US$ terms and transformed into logarithms.

One general way to investigate public expenditure with a panel data structure is to use a fixed-effects panel data model, where the dependent variable is the logarithm of expenditure per capita (at the aggregated and disaggregated levels), and the main control variable is the logarithm of GDP per capita. The following two specifications are first estimated:

Equation 6

$$\log(Exp_{c,t}) = \beta * \log(GDP_{c,t}) + \alpha_c + \delta_t + \varepsilon_{c,t}$$

Equation 7

$$\log(Exp_{c,t}) = \beta * \log(GDP_{c,t}) + \alpha_c + \delta_t + IncomeGroup_c * \delta_t + \varepsilon_{c,t}$$

where $\log(Expenditure_{c,t})$ denotes the total public expenditure and its component sectors and subsectors in country c in year t, $\log(GDP_{c,t})$ denotes gross national income per capita, α_c is country fixed effects, capturing individual country characteristics that are not varying across time, and δ_t is year fixed effects, capturing common factors that are specific to a given year. Equation 7 has an additional control, which is income group and year interaction terms (group-year fixed effects), assuming that each income group to which the country belongs has a varying time. β measures the elasticity of public expenditure with respect to income. Regression results are presented in table C.2, and all coefficients on GDP are statistically significant except for WSS. Comparing models 1 and 2, the coefficients are very robust and close to each other in terms of magnitude.

To correct for autocorrelation, the lag terms of the dependent variables and independent variables are added to equation 7, as shown in equation 8 and 9:

Equation 8

$$\log(Exp_{c,t}) = \beta_1 \log(GDP_{c,t}) + \beta_2 \log(GDP_{c,t-1}) + \beta_3 \log(Exp_{c,t-1}) + \alpha_c + \delta_t + IncomeGroup_c * \delta_t + \varepsilon_{c,t}$$

Equation 9

$$\begin{aligned}\log(Exp_{c,t}) = {} & \beta_1 \log(GDP_{c,t}) + \beta_2 \log(GDP_{c,t-1}) \\ & + \beta_3 \log(Exp_{c,t-1}) + \beta_4 \log(ToT_{c,t}) \\ & + \beta_5 \log(DebtService_{c,t}) + \beta_6\, GovDebt_{c,t-1} + \beta_7\, FiscalBalance_{c,t-1} \\ & + \beta_8\, Urbanization_{c,t} + \beta_9 \log(PopDensity_{c,t}) + \alpha_c + \delta_t \\ & + IncomeGroup_c * \delta_t + \varepsilon_{c,t}\end{aligned}$$

In equation 9, additional control variables are included, such as the log terms of trade, the log terms of debt service per capita, lagged general government gross debt (percent of GDP), lagged fiscal balance (percent of GDP), urbanization (percent of urban population of total) and the log term of population density.

Terms of trade reflecting country current account balance, and debt service reflecting government debt burden, both affect liquidity constraints faced by countries. Lagged gross debt and lagged fiscal balance capture credit constraints on public spending. Countries with higher terms of trade usually have a current account surplus and more abundant spending resources, but a higher debt-servicing burden limits countries' resources and restricts their cash flow to public sectors. On the other hand, larger gross debt and higher initial fiscal deficits reduce countries' access to capital markets, especially during economic downturns, because of the high risk of default.

The regression results with autocorrelation correction, based on model 2, with and without additional variables, are presented in table C.3. After correcting autocorrelation by adding lag terms of expenditure and GDP, the coefficients on GDP are systematically robust except that the magnitude for the water sector decreases from 0.773 to 0.684, and after adding more control variables, the coefficient is statistically significant at 10 percent level.

An alternative model specification is to take the first difference of model 2 with and without additional control variables, as follows:

Equation 10

$$\Delta\log(Exp_{c,t}) = \gamma_1\, \Delta\log(GDP_{c,t}) + \alpha_C + \delta_t + IncomeGroup_c * \delta_t + \varepsilon_{c,t}$$

Equation 11

$$\begin{aligned}\Delta\log(Exp_{c,t}) = {} & \gamma_1\, \Delta\log(GDP_{c,t}) + \gamma_3\, \Delta\log(ToT_{c,t}) \\ & + \gamma_3\, \Delta\log(DebtService_{c,t}) + \gamma_3 GovDebt_{c,t-1} + \gamma_4 FiscalBalance_{c,t-1} \\ & + \gamma_5 Urbanization_{c,t} + \gamma_6 \log(PopDensity_{c,t}) + \alpha_C + \delta_t \\ & + IncomeGroup_c * \delta_t + \varepsilon_{c,t}\end{aligned}$$

where γ_1 measures the responsiveness of public expenditure change with respect to output change. Comparing panels A and B in table C.4, which presents the estimation results based on equations 9 and 10 respectively, the coefficients on GDP have similar magnitude and singnificance level, with and without controlling for additional variables. The coefficients are not significant for either WSS or water. In principle, there is no difference between the models with correcting autocorrelation (equation 8) and the model with taking the first difference (equation 10) since the latter can be derived by rearranging the lag term of expenditure to the left side of equation 8, and then estimating the level term and lag term as one piece. The estimation of γ_1 shows how the percentage change in public expenditure responds to the percentage change in income, in other words, both public expenditure and income can be interpreted as growth.

TABLE C.1 Summary of Statistics for Dependent Variables and Independent Variables

Dependent variables	*n*	Mean	Std. dev.
Total expenditure	809	2.836	0.594
Human Development	812	2.422	0.752
Infrastructure	811	1.809	0.639
Energy	772	0.913	0.870
Transport	804	1.544	0.652
Agriculture	796	1.195	0.549
Water	769	0.831	0.767
Independent variables	***n***	**Mean**	**Std. dev.**
Log (GDP)	815	3.458	0.479
Log (ToT)	726	2.074	0.140
Log (DebtService)	716	1.482	0.764
GovDebt	801	45.584	27.849
FiscalBalance	804	−3.853	4.699
Urbanization	804	53.143	20.788
Log (PopDensity)	813	4.164	1.173

Source: (1) Expenditure data from BOOST (2009–20); (2) GDP (current, US$), and in logarithm per capita forms; (2) Net barter terms of trade index (2000 = 100), debt service on external debt, PPG (TDS, current), urban and total population and population density from WDI; General government gross debt (percent of GDP) and fiscal balance (percent of GDP) from Fiscal Space (Kose et al. 2017).
Note: PPG = public and publicly guaranteed; WDI = World Development Indicator; HD = human development; TDS = total debt service.

TABLE C.2 Determinants of Expenditure, OLS Regression Results of Baseline Model

	Log (Exp)						
	Total exp	HD	Infrastructure	Energy	Transportation	Agriculture	Water
Model 1: Baseline with two-way fixed effects							
Log (GDP)	0.933*** [0.157]	0.658** [0.276]	1.217*** [0.253]	1.081** [0.462]	1.490*** [0.432]	0.509** [0.210]	0.838** [0.380]
Constant	−0.409 [0.524]	0.0663 [0.923]	−2.347*** [0.853]	−2.738* [1.543]	−3.517** [1.454]	−0.559 [0.709]	−2.107 [1.286]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income group X Year FXs	No	No	No	No	No	No	No
R-squared	0.311	0.153	0.136	0.0399	0.11	0.0669	0.0431
Obs.	808	811	810	772	803	795	769
Model 2: Baseline with two-way fixed effects, income group and year interactions							
Log (GDP)	0.975*** [0.143]	0.736*** [0.262]	1.237*** [0.269]	1.090** [0.457]	1.487*** [0.435]	0.564*** [0.191]	0.801** [0.368]
Constant	−0.551 [0.479]	−0.195 [0.877]	−2.413*** [0.903]	−2.766* [1.529]	−3.508** [1.462]	−0.744 [0.644]	−1.986 [1.247]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income group X Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.355	0.212	0.169	0.0805	0.14	0.155	0.0665
Obs.	808	811	810	772	803	795	769

Source: (1) Expenditure data from BOOST (2009–20); (2) GDP (current, US$) from World Development Indicators (WDI).
Note: (1) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; (2) Both expenditure and GDP in current US$ terms and transformed into logarithms; HD = human development; FX = fixed effects.

TABLE C.3 Determinants of Expenditure, OLS Regression Results with Autocorrelation Correction, with and without Additional Controls (Elasticity Model)

	Log (Exp_t)						
	Total exp	HD	Infrastructure	Energy	Transport	Agriculture	Water
Panel A: Model 2 with lag terms (elasticity model)							
Log (GDP_*t*)	0.689*** [0.121]	0.702*** [0.150]	0.867*** [0.206]	0.736* [0.380]	0.963*** [0.342]	0.546*** [0.191]	0.773** [0.298]
Log (GDP_*t*–1)	−0.467*** [0.156]	−0.541*** [0.123]	−0.494** [0.234]	−0.436 [0.458]	−0.476 [0.427]	−0.395* [0.210]	−0.576* [0.344]
Log (Exp_*t*–1)	0.853*** [0.133]	0.868*** [0.0449]	0.696*** [0.0501]	0.613*** [0.0541]	0.700*** [0.0697]	0.673*** [0.0438]	0.648*** [0.0693]
Constant	−0.389 [0.284]	−0.256 [0.397]	−0.787 [0.648]	−0.786 [1.117]	−1.286 [1.066]	−0.188 [0.446]	−0.407 [0.831]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income group X Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.621	0.738	0.517	0.401	0.494	0.484	0.463
Obs.	740	743	742	705	735	727	704
Panel B: Model 2 with lag terms (elasticity model) and additional controls							
Log (GDP_*t*)	0.744*** [0.115]	0.797*** [0.135]	0.907*** [0.236]	0.546 [0.526]	0.827** [0.407]	0.582** [0.225]	0.684* [0.344]
Log (GDP_*t*–1)	−0.352*** [0.119]	−0.593*** [0.133]	−0.554* [0.289]	−0.377 [0.546]	−0.597 [0.514]	−0.282 [0.248]	−0.579 [0.378]
Log (Exp_*t*–1)	0.583*** [0.0548]	0.822*** [0.0514]	0.545*** [0.0440]	0.560*** [0.0642]	0.485*** [0.0483]	0.585*** [0.0493]	0.566*** [0.0870]
Log (ToT_*t*)	0.272*** [0.0911]	0.254*** [0.0928]	0.484** [0.182]	0.467 [0.372]	0.626*** [0.230]	0.331 [0.241]	0.0365 [0.400]

table continues next page

TABLE C.3 Determinants of Expenditure, OLS Regression Results with Autocorrelation Correction, with and without Additional Controls (Elasticity Model) *(continued)*

	Log (Exp_t)						
	Total exp	HD	Infrastructure	Energy	Transport	Agriculture	Water
Log (DebtService_*t*)	0.0158 [0.0283]	0.042 [0.0337]	0.0326 [0.0450]	0.026 [0.161]	0.0263 [0.0507]	−0.0143 [0.0400]	−0.0295 [0.0513]
GovDebt_*t*–1	−0.000239 [0.000335]	−8.76E-06 [0.000427]	−0.00171 [0.00117]	−0.00179 [0.00195]	−0.00532** [0.00227]	0.000442 [0.000559]	0.0000766 [0.00120]
FiscalBalance_*t*–1	0.00268* [0.00154]	0.0028 [0.00212]	−0.00229 [0.00406]	−0.000336 [0.00707]	−0.00925 [0.00647]	0.00328 [0.00289]	0.00175 [0.00637]
Urbanization_*t*	−0.00802 [0.00528]	−0.0182** [0.00829]	−0.0206* [0.0110]	−0.00287 [0.0317]	−0.0152 [0.0153]	−0.00838 [0.00812]	−0.0142 [0.0172]
Log(Pop_Den)_*t*	0.0796 [0.148]	0.203 [0.217]	0.177 [0.227]	0.604 [0.773]	−0.328 [0.386]	0.125 [0.216]	−0.142 [0.419]
Constant	−0.677 [0.612]	−0.798 [0.916]	−1.092 [1.277]	−3.592 [3.378]	1.023 [2.036]	−1.384 [0.998]	1.315 [1.741]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income group X Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.684	0.753	0.441	0.349	0.346	0.487	0.391
Obs.	574	577	576	559	569	570	541

Source: (1) Expenditure data from BOOST (2009–20); (2) GDP (current, US$), Net barter terms of trade index (2000 = 100), debt service on external debt, PPG (TDS, current), urban and total population and population density from WDI; General government gross debt (percent of GDP) and fiscal balance (percent of GDP) from Fiscal Space (Kose et al. 2017).
Note: (1) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; (2) Both expenditure, GDP and debt service per capita are in current US$ terms and transformed into logarithm; Term of trade is also in logarithm form; general government gross debt and fiscal balance shown as percent of GDP. FX = fixed effects; PPG = public and publicly guaranteed; WDI = World Development Indicators; HD = human development; TDS = total debt service.

TABLE C.4 Determinants of Public Expenditure, OLS Regressions Results of the First Difference, with and without Additional Controls (Expenditure Growth Model)

	ΔLog (Exp_*t*)						
	Total exp	SDH	Infrastructure	Energy	Transportation	Agriculture	Water
Panel A: Model 2 taking the first difference (expenditure growth model)							
ΔLog (GDP_*t*)	0.632*** [0.118]	0.651*** [0.127]	0.864*** [0.196]	0.662 [0.421]	0.884*** [0.288]	0.436** [0.214]	0.520 [0.313]
Constant	−0.0324 [0.0199]	−0.0199 [0.0167]	−0.0243 [0.0192]	−0.122*** [0.0452]	−0.0267 [0.0251]	−0.0518** [0.0259]	−0.0236 [0.0253]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income group X Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.236	0.204	0.116	0.0759	0.107	0.127	0.0771
Obs.	740	743	742	705	735	727	704
Panel B: Model 2 taking the first difference (growth model) with additional controls							
ΔLog(GDP_*t*)	0.692*** [0.116]	0.750*** [0.129]	0.971*** [0.234]	0.552 [0.516]	1.015*** [0.379]	0.429* [0.253]	0.604 [0.396]
ΔLog(ToT_*t*)	0.163 [0.154]	0.0161 [0.129]	0.269 [0.268]	1.059** [0.485]	0.399 [0.417]	0.217 [0.242]	0.157 [0.358]
ΔLog(Debt_*t*)	−0.0134 [0.0143]	0.0416* [0.0238]	−0.0169 [0.0439]	−0.00387 [0.156]	−0.0309 [0.0541]	−0.0162 [0.0388]	0.0156 [0.0459]
GovDebt_*t*–1	0.0000565 [0.000332]	0.0000223 [0.000443]	0.000412 [0.00121]	0.000766 [0.00156]	−0.00257* [0.00145]	0.00032 [0.000554]	0.000508 [0.000989]
FiscalBalance_*t*–1	0.00418*** [0.00136]	0.00355* [0.00204]	0.00275 [0.00488]	−0.00301 [0.00680]	−0.00469 [0.00675]	0.00301 [0.00240]	−0.00439 [0.00779]

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TABLE C.4 Determinants of Public Expenditure, OLS Regressions Results of the First Difference, with and without Additional Controls (Expenditure Growth Model) ***(continued)***

	ΔLog (Exp_t)						
	Total exp	SDH	Infrastructure	Energy	Transportation	Agriculture	Water
Urbanization_t	−0.00672 [0.00550]	−0.0162* [0.00892]	−0.00894 [0.00988]	−0.00559 [0.0178]	−0.0162 [0.0141]	−0.00735 [0.00551]	−0.00839 [0.00986]
Log(Pop_Den)_t	0.0717 [0.161]	0.0489 [0.184]	0.283 [0.264]	0.0639 [0.576]	0.0878 [0.367]	−0.0696 [0.147]	0.426* [0.253]
Constant	0.0473 [0.697]	0.639 [0.766]	−0.789 [1.205]	−0.0685 [2.211]	0.512 [1.646]	0.639 [0.642]	−1.474 [1.202]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income group X Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.308	0.246	0.122	0.0668	0.122	0.13	0.0861
Obs.	574	577	576	559	569	570	541

Source: (1) Expenditure data from BOOST (2009–20); (2) GDP (current, US$), Net barter terms of trade index (2000 = 100), debt service on external debt, PPG (TDS, current), urban and total population and population density from WDI; General government gross debt (percent of GDP) and fiscal balance (percent of GDP) from Fiscal Space (Kose et al. 2017).
Note: (1) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; (2) Both expenditure, GDP and debt service per capita are in current US$ terms and transformed into logarithm; Term of trade is also in logarithm form; general government gross debt and fiscal balance shown as percent of GDP. FX = fixed effects; PPG = public and publicly guaranteed; WDI = World Development Indicators; TDS = total debt service.

APPENDIX D

Correlates of Budget Execution

Aggregate Public Spending and Public Spending in Selected Sectors

Budget execution rates in the water sectors of 62 countries in the study sample are presented in table D.1 over the 12 years from 2009 to 2020. The trend over time is flat in most of the countries, and the execution rate remains below 1 for most of the years, indicated by the decadal average shown in the last column. Some countries show a large dispersion (variability) in their budget execution rates over time.

To find the determinants of the execution rates in the water sector, a model specification similar to the one in Part 3, Chapter 1 is adopted again using a fixed-effects panel data model. The dependent variable is the execution ratio (executed level of spending divided by the approved level of spending), and the main control variables are the logarithm of GDP per capita, and the same set of economic variables used in part 3, chapter 1.

A pooled OLS modification is used to find the determinants of budget execution, instead of employing a general and intuitive form of a two-way fixed-effects model specification is not appropriate. First, the joint *F*-test shows that the year dummies are not jointly significant, as shown in Panel A of table D.2. This is clear because from the visual inspection of yearly execution rates by each country in figure D.1, where the flatness of the yearly trend clearly shows of limited variation over years. Second, to select between Fixed Effects and Random Effects, a Hausman test is conducted. The regression results are reported in panels B and C of table D.2 and the small *P*-values listed at the bottom of panel C indicate the rejection of the null hypothesis, that a fixed-effects model specification is appropriate. The last step is to compare Random Effects and a Pooled OLS model specification. The Breusch-Pagan Lagrange multiplier (LM) is exploited to test whether the data meet the assumptions of running a pooled OLS. As shown at the bottom of panel C in the same table, the small *P*-values across different sectors show that a pooled-OLS model is more appropriate than a Random Effects model.

Table D.3 reports the regression results of using pooled OLS with one control variable (GDP per capital) and with additional economic controls in panels A and B, respectively. Since economic conditions offer only limited explanations of the disparity and dispersion in the execution rates, some aspects of the political and governance environment are considered. However, political and governance indices often have strong correlations with one another (multicollinearity), so extra caution has been taken in the selection of the variables. Table D.1 provides a pairwise correlation of the variables that were used which was helpful to select a smaller set of political and governance variables to minimize multicollinearity. The selection criteria employed within each category are: (1) the highest number of correlated variables to the execution rate in the water sector; and (2) the least mutual correlation between pairwise variables. For example, in the first category of Governance, Government Effectiveness was chosen as the most correlated variable (with a correlation coefficient of 0.313 with the execution rate). The most highly correlated ones—such as Regulatory Quality (correlation coefficient of 0.886 with Government Effectiveness), Rule of Law (correlation coefficient of 0.890) and Corruption of Control (correlation coefficient of 0.831)—were discarded. A similar technique was also applied to other categories.

The regression results with additional controls of political variables are reported in table D.3, panel C, with year dummies included. None of the economic variables have enough statistical power to explain the observed variation in the execution rates across all sectors, but nevertheless, the political and governance variables all have the expected signs of coefficients. This indicates that Improving government effectiveness, state legitimacy, and the quality of political institutions can all help to increase budget execution. In the meantime, however, high levels of fractionalization, fragility and conflict continue to obstruct budget execution.

FIGURE D.1 Country-Level Execution Rates in Water, 2009–20

Region	Country	2009-20	Average
East Asia and Pacific	Fiji	0.98 0.00	0.47
	Myanmar	1.37 0.41	1.00
	Papua New Guinea	0.84 0.46	0.71
	Solomon Islands	0.20 0.22	0.24
	Timor-Leste	0.32 0.36	0.92
Europe and Central Asia	Albania	0.76 0.24	0.80
	Armenia	0.72 0.47	0.87
	Bulgaria	0.65 0.74	0.94
	Croatia	1.00 0.95	0.99
	Georgia	0.77 2.15	1.15

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FIGURE D.1 Country-Level Execution Rates in Water, 2009–20 *(continued)*

Region	Country	2009-20		Average
	Kosovo	0.63	0.93	0.72
	Moldova	1.05	1.63	1.10
	North Macedonia	0.42	0.77	0.58
	Poland	1.00	0.66	0.93
	Romania	0.65	2.41	1.62
	Ukraine	0.72	0.75	0.73
Middle East and North Africa	Lebanon	0.10	0.29	0.25
	Oman	0.24	0.06	0.24
	Saudi Arabia	1.04	1.07	1.07
	Tunisia	0.91	0.82	0.75
South Asia	Afghanistan	0.15	0.19	0.21
	Bangladesh	1.00	1.06	0.96
	Pakistan	0.81	0.89	0.65
Latin America & the Caribbean	Argentina	0.94	0.94	0.97
	Brazil	0.32	0.65	0.35
	Chile	1.24	1.04	1.09
	Costa Rica	0.81	1.06	0.77
	Dominican Republic Ecuador	0.46	1.08	0.80
	Ecuador	1.53	0.11	0.70
	El Salvador	0.99	1.06	0.95
	Guatemala	0.78	0.58	0.79
	Haiti	0.76	0.04	0.27
	Jamaica	0.04	0.36	0.47
	Mexico	1.09	1.06	1.06
	Panama	0.35	0.83	0.58
	Paraguay	0.57	0.82	0.64

figure continues next page

FIGURE D.1 Country-Level Execution Rates in Water, 2009–20 ***(continued)***

Region	Country	2009-20	Average
	Peru	1.25 0.42	0.99
	Trinidad and Tobago	0.95 0.41	0.95
	Uruguay	0.93 1.08	1.00
Sub-Saharan Africa	Angola	1.06 0.66	0.50
	Benin	0.21 0.39	0.21
	Burkina Faso	0.56 0.50	0.49
	Cabo Verde	0.56 0.25	0.40
	Cameroon	0.78 1.06	0.66
	Ethiopia	1.00 1.00	1.00
	Kenya	0.63 0.87	0.74
	Lesotho	0.28 0.32	0.36
	Liberia	0.08 1.12	0.54
	Mali	1.00 0.93	0.76
	Mauritania	0.10 0.13	0.36
	Mauritius	0.68 0.83	0.68
	Mozambique	0.95 1.61	0.87
	Namibia	0.90 0.90	0.78
	Niger	0.37 1.27	0.59
	Senegal	1.00 1.00	1.00
	Sierra Leone	0.01 0.31	0.32
	Tanzania	0.62 0.74	0.65
	Togo	0.14 0.12	0.13
	Uganda	0.57 0.34	0.51
	Gambia, The	0.02 2.99	1.36
	Malawi	0.62 1.19	0.53
	South Africa	1.65 0.60	0.98

Source: Elaborations using World Bank BOOST database.

TABLE D.1 Correlation Coefficients of Execution Rates in Water and Political and Goverance Variables

		Outcome	Governance indicators				Fractionalization			Fragility and conflicts		Institutionalization		
		Exe. water	Gov. eff	Regulatory quality	Rule of law	Corruption control	Ethnic	Language	Religion	State legitimacy	Fragile and conflict-affected status	Economic	Legal	Political
Outcome	Exe. water	1												
Governance	Government effectiveness	**0.313*** **	1											
	Regulatory quality	0.289***	0.886***	1										
	Rule of law	0.274***	0.890***	0.846***	1									
	Corruption control	0.270***	0.831***	0.751***	0.899***	1								
Fractionalization	Ethnic fractionalization	−0.247***	−0.488***	−0.444***	−0.449***	−0.430***	1							
	Language fractionalization	−0.218***	−0.543***	−0.452***	−0.414***	−0.419***	0.828***	1						
	Religion fractionalization	**−0.233*** **	**−0.0391**	−0.00638	−0.0313	−0.101*	0.350***	0.441***	1					
Fragility and conflicts	State legitimacy	**0.191*** **	**0.684*** **	0.610***	0.707***	0.722***	−0.350***	−0.416***	**−0.0929***	1				
	Fragile and conflict-affected status	**−0.191*** **	**−0.526*** **	−0.450***	−0.442***	−0.339***	0.282***	0.324***	**0.0466**	**0.325*** **	1			
Institutionalization	Quality of economic institution	0.209***	0.738***	0.847***	0.677***	0.546***	−0.387***	−0.395***	0.0962*	−0.485***	−0.458***	1		
	Quality of legal institution	0.198***	0.798***	0.764***	0.871***	0.819***	−0.383***	−0.366***	0.0767	−0.779***	−0.371***	0.654***	1	
	Quality of political institution	**0.240*** **	**0.732*** **	0.726***	0.709***	0.672***	−0.344***	−0.419***	**0.0745**	**−0.831*** **	**−0.428*** **	0.635***	0.831***	1

Source: Government effectiveness and regulatory quality from the Worldwide Governance Indicator (WBGI); State legitimacy from Fragile States Index (https://fragilestatesindex.org/indicators/p1); performance of political institutions from Kuncic (2014). All variables are coded in a positive direction.
Note: * *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01.

TABLE D.2 Determinants of Execution Rates in Water Sector, OLS Regression Results with Two-Way Fixed Effects, Country-Level Fixed Effects, and Random Effects

	Total exp	Human Development	Infrastructure	Energy	Transport	Agriculture	Water
Panel A: Two-way fixed effects							
Log (GDP)	0.0480 [0.218]	0.382 [0.416]	-0.0841 [0.542]	-0.722 [0.493]	0.00556 [0.768]	0.229 [0.527]	−0.0561 [0.337]
Log (ToT)	0.377 [0.372]	1.499*** [0.421]	0.610 [0.399]	1.024 [0.641]	0.411 [0.597]	0.691 [0.585]	1.230** [0.541]
Log (DebtService)	0.0229 [0.0646]	−0.0203 [0.0657]	0.135 [0.0987]	0.0772 [0.121]	0.0675 [0.113]	0.118 [0.0751]	0.0543 [0.0773]
GovDebt	−0.000764 [0.00147]	0.00394 [0.00304]	−0.00243 [0.00215]	−0.00101 [0.00250]	−0.00413 [0.00440]	0.00655* [0.00350]	−0.0000279 [0.00178]
FisicalBalance	−0.00178 [0.00577]	−0.0148 [0.0114]	−0.00519 [0.00932]	−0.00650 [0.00962]	−0.00313 [0.0112]	0.00635 [0.00857]	0.00312 [0.00818]
Urbanization	−0.0459** [0.0179]	−0.0344 [0.0240]	−0.0848** [0.0365]	−0.0187 [0.0373]	−0.0695* [0.0354]	−0.0591** [0.0252]	−0.0270 [0.0287]
Log (PopDensity)	0.0685 [0.793]	0.188 [1.241]	0.284 [1.527]	0.801 [1.741]	0.765 [1.496]	1.083 [1.403]	−0.369 [1.439]
Constant	2.012 [1.580]	−2.244 [2.905]	3.399 [3.013]	0.530 [2.851]	2.039 [3.540]	−0.815 [2.706]	0.234 [2.929]
Country FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FXs *F*-test *P*-value	0.566	0.399	0.127	0.348	0.381	0.150	0.456
R-squared	0.0806	0.108	0.0970	0.0454	0.0698	0.109	0.0498
Obs.	599	600	573	534	551	571	540

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TABLE D.2 Determinants of Execution Rates in Water Sector, OLS Regression Results with Two-Way Fixed Effects, Country-Level Fixed Effects, and Random Effects *(continued)*

	Total exp	Human Development	Infrastructure	Energy	Transport	Agriculture	Water
Panel B: Country-level Fixed Effects							
Log (GDP)	0.246** [0.122]	0.478*** [0.170]	0.221 [0.240]	−0.532* [0.319]	0.413 [0.294]	0.282 [0.242]	0.108 [0.228]
Log (ToT)	0.337* [0.203]	1.591*** [0.290]	0.666* [0.404]	1.170** [0.516]	0.575 [0.469]	0.857** [0.401]	1.185*** [0.371]
Log (DebtService)	0.0477 [0.0392]	−0.0309 [0.0547]	0.147* [0.0762]	0.0860 [0.101]	0.0653 [0.0916]	0.0841 [0.0768]	0.0794 [0.0729]
GovDebt	−0.00000712 [0.000715]	0.00396*** [0.000998]	−0.00105 [0.00145]	−0.000294 [0.00205]	−0.00289 [0.00217]	0.00541*** [0.00153]	0.00107 [0.00141]
FisicalBalance	−0.000422 [0.00340]	−0.0132*** [0.00474]	−0.00367 [0.00691]	−0.00187 [0.00870]	0.000280 [0.00840]	0.00773 [0.00673]	0.00372 [0.00665]
Urbanization	−0.0299*** [0.00689]	−0.0356*** [0.00956]	−0.0689*** [0.0135]	−0.0175 [0.0186]	−0.0621*** [0.0163]	−0.0736*** [0.0136]	−0.0104 [0.0128]
Log (PopDensity)	0.903** [0.375]	0.230 [0.522]	1.094 [0.743]	1.141 [0.993]	1.284 [0.915]	0.577 [0.728]	0.262 [0.706]
Constant	−0.872 [0.641]	−2.726*** [0.894]	−0.00508 [1.234]	−1.112 [1.656]	−0.879 [1.548]	0.437 [1.254]	−2.253* [1.217]
R-squared	0.0000683	0.00239	0.0323	0.00618	0.0000488	0.00317	0.0000698
Obs.	599	600	573	534	551	571	540
Panel C: Random effects							
Log (GDP)	0.0808 [0.0754]	0.363*** [0.131]	0.0131 [0.165]	−0.221 [0.178]	0.125 [0.176]	0.00319 [0.150]	0.0668 [0.141]
Log (ToT)	−0.0446 [0.131]	0.668*** [0.232]	0.0335 [0.287]	0.637** [0.296]	−0.441 [0.297]	0.208 [0.261]	0.432* [0.240]
Log (DebtService)	0.0514 [0.0350]	−0.0437 [0.0523]	0.126* [0.0708]	0.135 [0.0866]	0.0527 [0.0812]	0.0742 [0.0697]	0.132** [0.0646]
GovDebt	−0.000758 [0.000594]	0.00276*** [0.000913]	−0.00300** [0.00125]	−0.00124 [0.00153]	−0.00496*** [0.00160]	0.00191 [0.00124]	−0.000844 [0.00114]

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TABLE D.2 Determinants of Execution Rates in Water Sector, OLS Regression Results with Two-Way Fixed Effects, Country-Level Fixed Effects, and Random Effects *(continued)*

	Total exp	Human Development	Infrastructure	Energy	Transport	Agriculture	Water
FisicalBalance	−0.00139 [0.00327]	−0.0115** [0.00469]	−0.00582 [0.00663]	0.00204 [0.00819]	−0.00236 [0.00794]	0.00900 [0.00654]	0.00377 [0.00624]
Urbanization	−0.00182 [0.00154]	−0.00786** [0.00314]	−0.00164 [0.00359]	0.00252 [0.00343]	−0.00140 [0.00352]	−0.00564* [0.00311]	−0.00209 [0.00288]
Log (PopDensity)	0.0427 [0.0431]	0.135 [0.0932]	−0.0955 [0.102]	0.0783 [0.0942]	0.0884 [0.0977]	−0.0196 [0.0872]	0.0911 [0.0881]
Constant	0.674* [0.344]	−1.565*** [0.606]	0.918 [0.752]	−0.151 [0.789]	1.455* [0.792]	0.598 [0.688]	−0.650 [0.644]
Hausman test *P*-value	0.00108	0.00000312	0.0000269	0.159	0.00197	0.00000263	0.0282
Breusch-Pagan Lagrange multiplier (LM) test *P*-value	1.53e-89	2.68e-239	7.81e-123	2.01e-55	4.38e-70	8.19e-75	1.19e-97
R-squared	0.0454	0.00858	0.0286	0.0342	0.0639	0.0136	0.0646
Obs.	599	600	573	534	551	571	540

Source: Expenditure data from BOOST (2009–20), GDP (current, US$), Net barter terms of trade index (2000 = 100), debt service on external debt, PPG (TDS, current), urban and total population and population density from WDI, General government gross debt (percent of GDP) and fiscal balance (percent of GDP) from Fiscal Space.
Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. FX = **Fixed effects**; PPG = public and publicly guaranteed; WDI = World Bank Indicator; HD = human development; TDS = total debt service.

TABLE D.3 Determinants of Execution, Pooled-OLS, with and Without Economic and Political Variables

	Total exp	Human Development	Infrastructure	Energy	Transport	Agriculture	Water
Model 1: Pooled OLS							
Log (GDP)	0.0851* [0.0465]	0.0960 [0.0609]	0.133* [0.0793]	0.0968 [0.0854]	0.0572 [0.0898]	-0.00243 [0.0779]	0.209** [0.0790]
Constant	0.601*** [0.162]	0.654*** [0.204]	0.372 [0.278]	0.500 [0.311]	0.705** [0.322]	0.883*** [0.278]	−0.0111 [0.275]
Year dummies	No	No	No	No	No	No	No
R-squared	0.0317	0.0146	0.0226	0.00981	0.00349	0.00000859	0.0592
Obs.	772	771	741	678	716	711	706
Model 2: Pooled OLS with economic variables							
Log (GDP)	0.0186 [0.0735]	0.246 [0.179]	−0.0450 [0.216]	−0.269 [0.173]	0.0361 [0.193]	−0.0852 [0.173]	−0.108 [0.198]
Log (ToT)	−0.287* [0.149]	−0.544** [0.262]	−0.263 [0.350]	0.374 [0.316]	−0.893** [0.428]	−0.0787 [0.261]	−0.0234 [0.249]
Log (DebtService)	0.0526 [0.0646]	−0.0418 [0.103]	0.0974 [0.125]	0.155 [0.129]	0.0473 [0.131]	0.0998 [0.108]	0.277*** [0.0891]
GovDebt	−0.00110 [0.00111]	0.00286 [0.00200]	−0.00252 [0.00220]	−0.00207 [0.00248]	−0.00469** [0.00196]	0.000458 [0.00263]	−0.00479*** [0.00152]
FiscalBalance	0.00177 [0.00676]	0.00783 [0.00958]	−0.00542 [0.0125]	0.0170 [0.0132]	−0.00284 [0.0128]	0.0228* [0.0130]	−0.00607 [0.00998]
Urbanization	0.0000263 [0.00147]	−0.00268 [0.00264]	0.00280 [0.00294]	0.00386 [0.00324]	0.00162 [0.00326]	−0.00223 [0.00323]	−0.00149 [0.00290]
Log (PopDensity)	0.0234 [0.0329]	0.0558 [0.0710]	−0.0861 [0.0908]	0.0492 [0.0904]	0.0346 [0.0906]	0.00767 [0.0645]	0.0929 [0.0791]
Constant	1.351*** [0.382]	1.273* [0.694]	1.498 [0.932]	0.592 [0.793]	2.625** [1.140]	1.329** [0.623]	0.778 [0.625]
Year dummies	No	No	No	No	No	No	No
R-squared	0.0706	0.106	0.0537	0.0459	0.0858	0.0312	0.117
Obs.	599	600	573	534	551	571	540

table continues next page

TABLE D.3 Determinants of Execution, Pooled-OLS, with and Without Economic and Political Variables *(continued)*

	Total exp	HumanDevelopment	Infrastructure	Energy	Transport	Agriculture	Water
Model 3: Pooled OLS with economic and political controls							
	Total exp	**HumanDevelopment**	**Infrastructure**	**Energy**	**Transport**	**Agriculture**	**Water**
Log (GDP)	0.0215 [0.0854]	0.166 [0.185]	−0.138 [0.209]	−0.242 [0.217]	−0.140 [0.199]	−0.179 [0.187]	−0.127 [0.197]
Log (ToT)	−0.304** [0.140]	−0.486* [0.243]	−0.173 [0.361]	0.508* [0.284]	−0.832** [0.394]	0.000988 [0.223]	0.120 [0.218]
Log (DebtService)	0.0498 [0.0488]	−0.0554 [0.0835]	0.0568 [0.116]	0.145 [0.0981]	0.0720 [0.109]	0.0410 [0.0956]	0.164* [0.0823]
GovDebt	−0.00140 [0.00116]	0.00236 [0.00239]	−0.00173 [0.00256]	−0.000643 [0.00270]	−0.00510** [0.00203]	0.00160 [0.00292]	−0.00235 [0.00175]
FisicalBalance	0.00120 [0.00666]	0.00230 [0.00934]	−0.00264 [0.0119]	0.0173 [0.0138]	−0.000209 [0.0133]	0.0268** [0.0130]	−0.00310 [0.0108]
Urbanization	0.000199 [0.00134]	−0.000553 [0.00278]	0.00294 [0.00333]	0.00215 [0.00267]	0.00173 [0.00362]	−0.00191 [0.00300]	−0.00207 [0.00314]
Log (PopDensity)	0.0127 [0.0303]	−0.000384 [0.0615]	−0.0898 [0.0968]	0.0962 [0.0810]	0.0466 [0.103]	0.0179 [0.0550]	0.104 [0.0718]
Government effectiveness indicator	0.0652 [0.0400]	0.262** [0.128]	0.256** [0.105]	0.0196 [0.107]	0.156 [0.106]	0.140* [0.0745]	0.152* [0.0904]
Religion fractionalization	−0.00948 [0.0693]	0.172 [0.169]	−0.273 [0.283]	−0.404** [0.168]	−0.226 [0.294]	−0.210 [0.179]	−0.523*** [0.179]
State legitimacy	−0.0137 [0.0203]	−0.0886** [0.0424]	−0.0566 [0.0402]	−0.0772* [0.0419]	−0.0129 [0.0371]	−0.00354 [0.0317]	−0.0499* [0.0292]
Fragile and conflict-affected status	0.0295 [0.0504]	0.137 [0.0826]	0.139 [0.127]	0.0415 [0.105]	0.189 [0.130]	0.0287 [0.106]	−0.0658 [0.0915]
Quality of political institutions	−0.141 [0.309]	0.313 [0.581]	0.412 [0.562]	0.957 [0.704]	0.459 [0.532]	0.287 [0.534]	0.573 [0.498]
Constant	1.404*** [0.419]	0.714 [0.880]	1.293 [1.121]	−0.620 [0.964]	2.886** [1.225]	1.493* [0.842]	0.337 [0.747]
Year dummies	No	No	No	No	No	No	No
R-squared	0.0901	0.188	0.0956	0.0775	0.118	0.0617	0.192
Obs.	588	589	562	526	540	562	529

Source: Expenditure data from BOOST (2009–20); GDP (current, US$), Net barter terms of trade index (2000 = 100), debt service on external debt, PPG (TDS, current), urban and total population and population density from WDI; General government gross debt (percent of GDP) and fiscal balance (percent of GDP) from Fiscal Space (Kose et al. 2017); Government effectiveness and regulatory quality from the WBGI; Fractionalization from Alesina et al. (2003); List of fragile, conflict-affected, and violence-affected countries per year, from World Bank (2017); State legitimacy from Fragile States Index (https://fragilestatesindex.org/indicators/p1); performance of political institutions from Kuncic (2014). All variables are coded in a positive direction.
Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Simple pooled OLS with robust standard errors clustered at the country level. PPG = public and publicly guaranteed; WDI = World Development Indicators; WBGI = Worldwide Governance Indicator; TDS = total debt service.

APPENDIX E

Estimating the Efficiency of Public Expenditure Using the Malmquist Productivity Index

Productivity and Efficiency- Concepts, and Selected Results

Data Envelopment Analysis (DEA) is a non-parametric technique for estimating the production frontier. It is a multi-factor productivity analysis model that can be used to measure the relative efficiencies of a homogenous set of decision-making units (DMUs). In other words, it measures the efficiency of each DMU (countries in this case) within a group relative to the observed most efficient unit within that group. It serves as a benchmark and computes the relative distance between each unit and the frontier. The frontier is constructed by using observed input and output data that belongs to the most efficient/ productive unit. The distance from the frontier to each point within the frontier can be interpreted as the economic performance of the units in the sample relative to the best performing unit. DEA allows multiple input –outputs to be considered at the same time without any assumption on data distribution.

The public spending efficiency analysis in part 3, chapter 3 adopts a technique of Malmquist Productivity Index (MPI) using a DEA frontier. The MPI measurement based on the DEA frontier suggested by Fare et al. (1994) is the most prevalent method to decompose the productivity changes into changes in efficiency and technology, along with time variations. The statistical programming used in this analysis is a user-written DEA codes by Ji and Lee (2010). It takes a three-step approach: First, for each combination of inputs and outputs, an efficiency frontier is generated consisting of the most efficient units based on a constant return of scale (whereby an increase in inputs results in a proportionate increase in the output levels). Second, the MPI measures the difference between each unit of the efficiency frontier over time; for example, since this study sample starts in 2009, the efficient/efficiency frontier is calculated for 2009 and 2010, and the first value of the MPI for this dyad is the difference in deviations to the efficiency frontier of a unit for 2009 and 2010. The distance function to the efficiency frontier is calculated using the following equations:

Equation 12

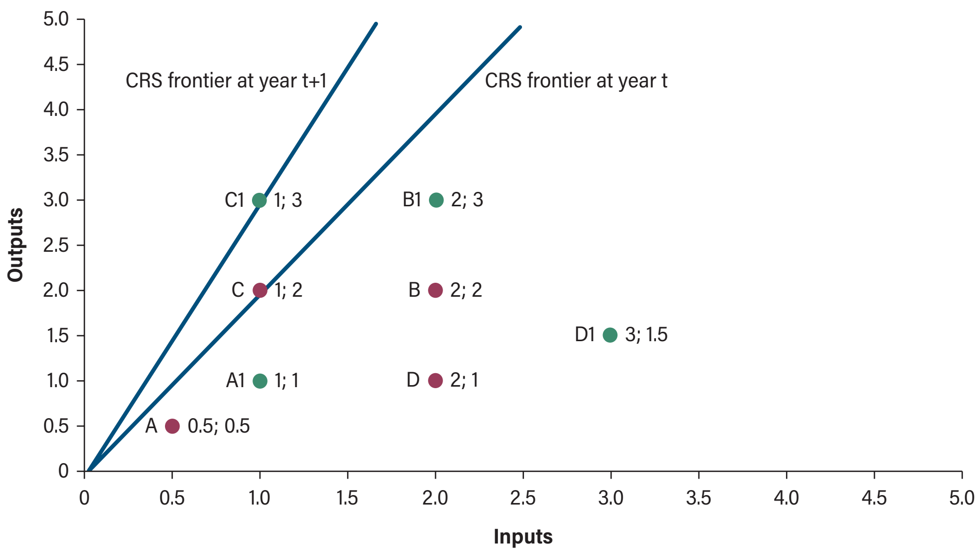
$$MPI^t = \frac{E^t\left(x^{t+1},\ y^{t+1}\right)}{E^t\left(x^t,\ y^t\right)}$$

Equation 13

$$MPI^{t+1} = \frac{E^{t+1}\left(x^{t+1},\ y^{t+1}\right)}{E^{t+1}\left(x^{t},\ y^{t}\right)}$$

where MPI is the Malmquist Index in periods t and $t + 1$, and x and y are inputs and outputs. Finally, once the MPI is calculated for each year, the geometric mean of the value for each country between each 2 years are taken. Suppose there are four units that use one input and one output for period t and $t + 1$, and that the units have the following combinations of inputs/outputs in figure E.1: A (0.5, 0.5), B (2, 2), C (1, 2), and D (2, 1) at t, and A1(1, 1), B1(2, 3), C1(1, 3), and D1(3, 1.5) at $t + 1$. Suppose that in the figure, C is the most efficient unit and that B had no efficiency gains between t and $t + 1$ because its distance to the efficiency frontier has remained equal.

FIGURE E.1 The MPI Using a Constant Return of Scale DEA



Source: This figure presents an example of the MPI represented by means of the DEA distance function. The input/output efficiency of four countries are represented by A, B, C and D in year t and by A1, B1, C1 and D1 in year $t + 1$. The MPI calculates the change in the distance of each unit to the efficiency frontier for period t and $t + 1$. The closer the unit moves to the efficiency frontier, the higher the efficiency. For each country, the ratio between the two distance functions measured at t and $t + 1$ is calculated (Sarmento et al. 2017).
Note: MPI = Malmquist Productivity Index; DEA = data envelopment analysis.

The last step is to take the geometric mean of equations (1) and (2), which defines the MPI. It can further be decomposed into an efficiency change and a technical change following Fare et al. (1994).

Equation 14

$$MPI = \frac{E^{t+1}\left(x^{t+1},\ y^{t+1}\right)}{E^{t}\left(x^{t},\ y^{t}\right)} \left[\frac{E^{t+1}\left(x^{t+1},\ y^{t+1}\right)}{E^{t}\left(x^{t},\ y^{t}\right)} \times \frac{E^{t+1}\left(x^{t+1},\ y^{t+1}\right)}{E^{t}\left(x^{t},\ y^{t}\right)}\right]^{1/2}$$

$$MPI = \textit{Technical Efficiency Change (EC)} \times \textit{Technology Change (TC)}$$

The first term in equation 14 represents the technical efficiency change between two periods. It captures whether the observation is getting closer to the frontier over time, while the frontier (technology) shift is captured by the geometric mean of the terms in the bracket. Technical efficiency change (often simply referred to as efficiency change, or EC) can be thought of as the technological catch-up effect, an indication that resources are being used more efficiently. If EC is 1, then there is no change in efficiency between two periods. If EC exceeds 1, the distance of observation to the frontier is closing. If it is less than 1, the distance is increasing.

Technological change (TC) is associated with a “displacement effect” or “frontier shift,” and as a result, the entire set of production possibilities frontiers changes over time. With TC equal to 1, technological frontier remains as is; greater than 1, there is technological progress; and less than 1, there is technological regress.

Overall, if the MPI exceeds 1, there is a growth in productivity. Values less than 1 indicate a decline in productivity (deterioration) and a value of 1 denotes productivity stagnation or no change in productivity.

Technical efficiency EC can be decomposed into two components: a pure efficiency change (PECH) and a scale efficiency change (SECH). While PECH is related to the learning process in the decision-making units, a scale efficiency change indicates success in producing at optimal scale.

As in almost all empirical models, too small a number of DMUs might create concerns for the degrees of freedom when measuring productivity. This issue has been addressed by following Cooper et al. (2004). The authors suggest that degrees of freedom is not a concern if the following equation holds: $n \geq \max\{m \times s, 3(m+s)$ where n is the number of DMUs (countries, $n = 58$), m represents the number of inputs (CAPEX and OPEX, $m = 2$), and s is the access rate to water supply and sanitation ($s = 2$). This implies that the number of countries should be greater than 12 (= 3(2 + 2)). In addition, we study a period of 12 years (2009–20). This gives us enough observations to estimate productivity changes.

As discussed in part 3, chapter 3, the countries within the study sample experienced a decline of 6 percent in total factor productivity (TFP) when delivering basic services and a 5 percent decline for high-level services. To visualize this, figures E.2 and E.3 offer two types of comparisons for TFP—one against a benchmark of 1, representing stagnant growth, and another against the overall sample mean, at the country level. Among the countries providing basic access, only 16 exceed the stagnation benchmark, while 17 surpass it for higher-level access. Notably, for both service levels, countries performing above the benchmark of the overall sample mean are only slightly outperforming their counterparts.

FIGURE E.2 Country-Level Deviations from Benchmark and Overall Mean, Basic-Level Service

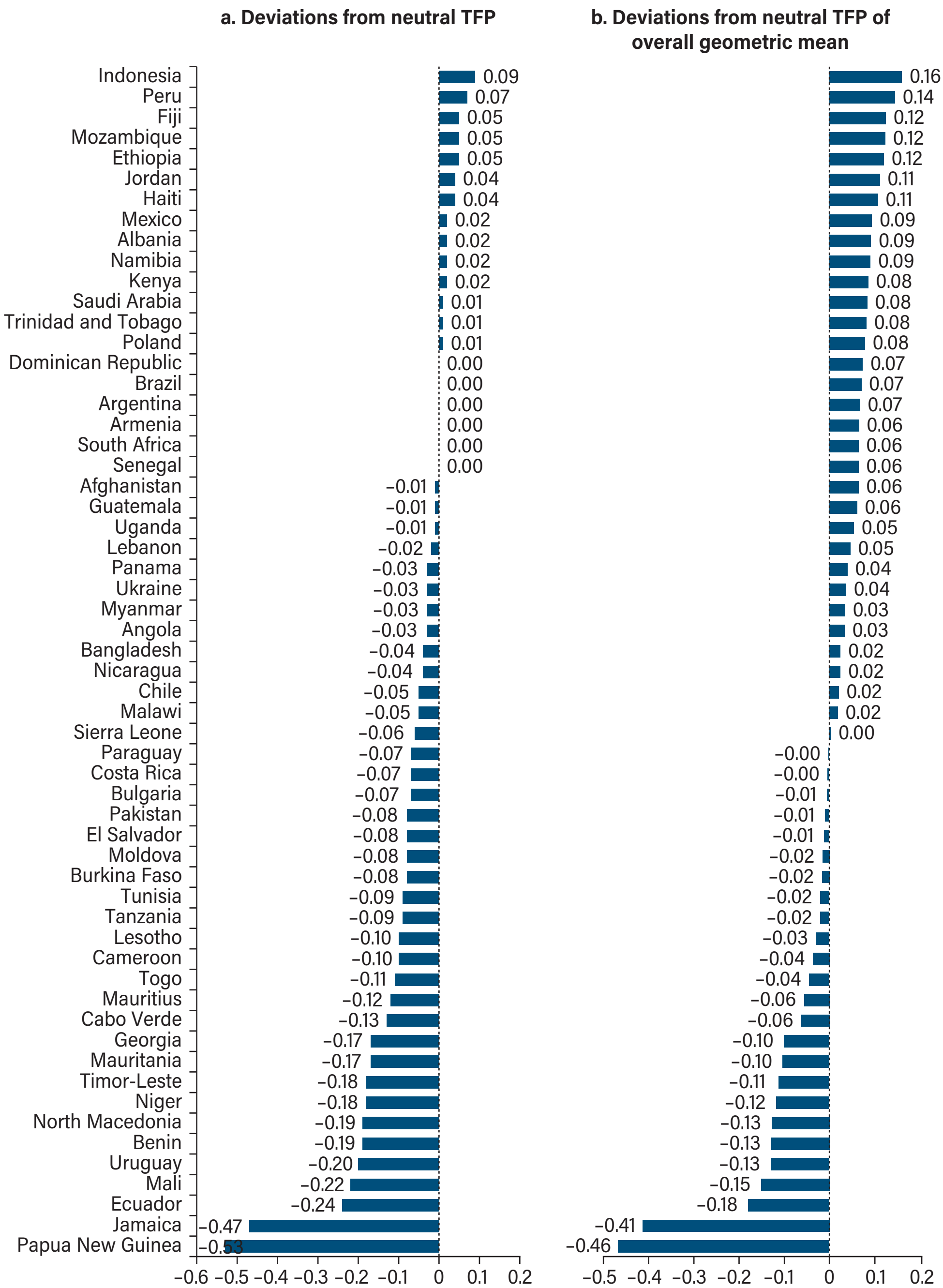


FIGURE E.3 Country-Level Deviations from Benchmark and Overall Mean, Basic-Level Service

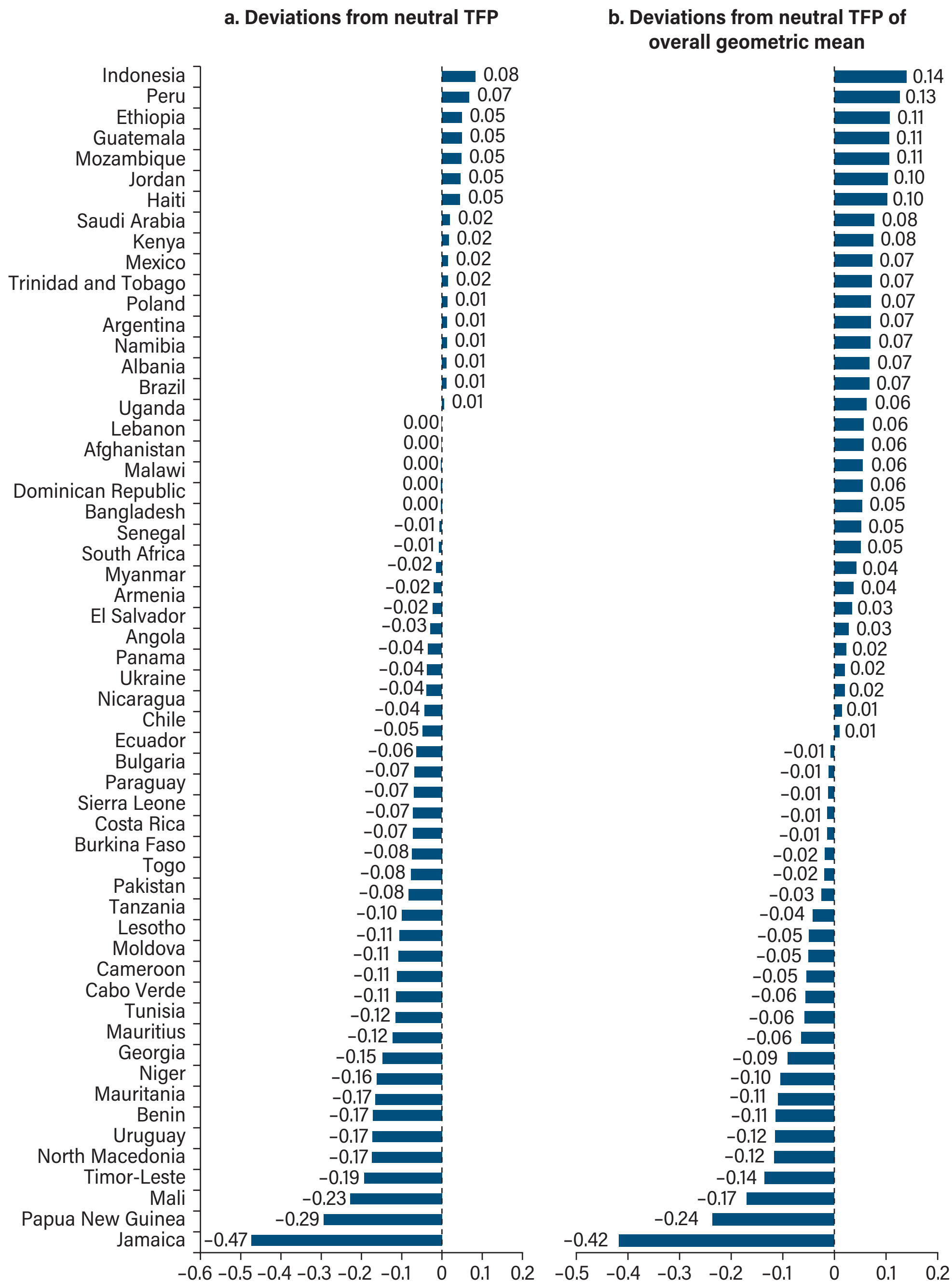


Table E.1 further provides insight into these deviations from neutral TFP and from TFP of the overall geometric mean for both basic and higher-level services in different regions. The values indicate region-to-region variations in productivity performance. For example, in the EAP region, the deviations from neutral TFP for basic and higher-level services are –0.12 and –0.08, respectively, while in ECA, these values are –0.06 and –0.07. This pattern of deviations provides a comprehensive overview of the productivity dynamics within the analyzed regions for different service levels.

TABLE E.1 Regional Deviations from Neutral TFP and Overall Mean

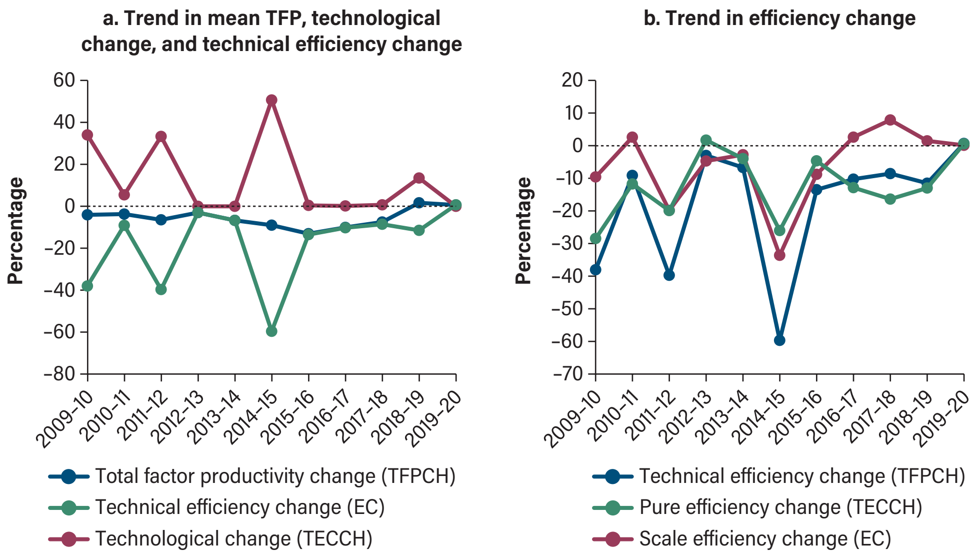
	Basic-level services		Higher-level services	
	Deviations from Benchmark TFP	Deviations from overall TFP mean	Deviations from Benchmark TFP	Deviations from overall TFP mean
EAP	−0.12	−0.06	−0.08	−0.02
ECA	−0.06	0.00	−0.07	−0.02
LAC	−0.07	0.00	−0.05	0.00
MENA	−0.01	0.05	−0.01	0.04
SA	−0.05	0.02	−0.03	0.02
SSA	−0.07	−0.01	−0.07	−0.02
All available	−0.06	0.00	−0.05	0.00

Source: World Bank elaborations.
Note: TFP = Total Factor Productivity.

MARGINAL IMPROVEMENT OVER THE YEARS

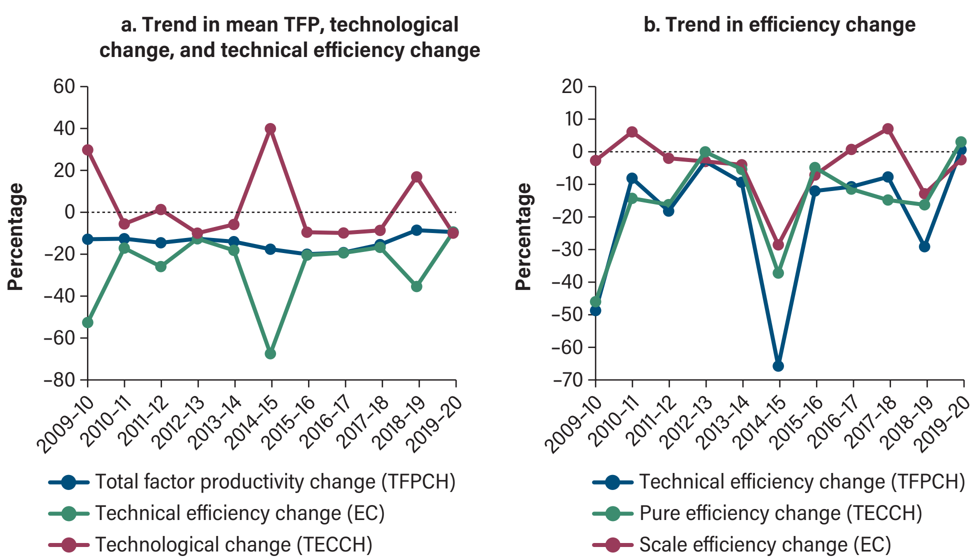
Figure E.4 panel a illustrates the yearly trend of the mean of the Malmquist Index's TFP and its two components—technological change and efficiency change. Panel b of the same figure shows the breakdown of efficiency change, including its two constituents, scale efficiency change and PECH. For linearity and additivity purposes, all the indices and their constituents are expressed in logarithmic form. The vertical axis of the figure denotes percentage change in TFP. Generally, efficiency change and technological change move in opposite directions. In recent years, a slight increase in total productivity has been observed, primarily driven by an upward shift in efficiency change. In earlier years, PECH and scale efficiency tended to move in the same direction. But since 2016, scale efficiency has shown positive change, which is insufficient to offset the negative change of pure efficiency.

FIGURE E.4 Year-to-Year Malmquist Index—TFP and its Components, Basic-Level Service



As figure E.5 illustrates, the yearly trend seen in the TFP of high-level service production follows a similar pattern to that of basic service production, but with a more detailed view of the components involved. Generally, high-level service production experiences a slight decrease in efficiency (from pure efficiency loss) compared to basic service production, but this is offset by greater technological progress, resulting in a similar level of total productivity.

FIGURE E.5 Year-to-Year Malmquist Index—TFP and its Components, High-Level Service



Both figures E.4 and E.5 illustrate the movements of index components in the WSS subsector of various countries. It is evident that the movements of these components are quite volatile, with a large spike observed during 2014 to 2015 in both efficiency change and technological change. This suggests the presence of certain underlying structural changes at work in the WSS sectors of all the countries during this period, which resulted in such lock-step fluctuations.

As time progressed, efficiency improved gradually, as did total productivity. Such improvements, it should be borne in mind, are not a one-time occurrence but rather a gradual process that reflects continuous effort and monitoring. Thus, it is essential for policymakers and stakeholders to pay attention to the underlying factors driving such changes and take appropriate actions to ensure sustained improvements in the WSS subsector.

It is also important to conduct further research to identify the factors that led to the observed volatility in the index components during 2014 and 2015. This could provide insights into the dynamics of the WSS subsector that could inform policy decisions and interventions. Additionally, it is necessary to examine the interplay between efficiency change and technological change and explore ways to optimize both to improve the WSS subsector, in order to ensure that the subsector continues to upgrade and meet the population's needs.

APPENDIX F

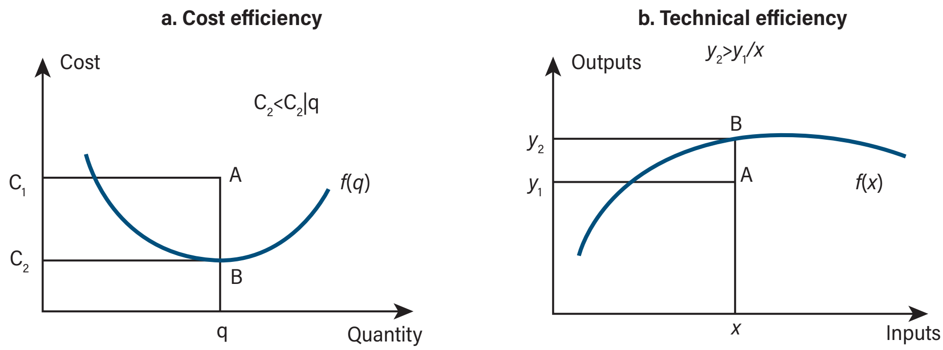
Estimating Efficiency Using a Stochastic Production Function

A production plan is considered **technically inefficient** if a higher level of output is technically attainable from a given set or combination of inputs (output-oriented measure), or if the observed output level can be produced using fewer inputs (input-oriented measure) (Kumbhakar et al. 2015). Alternatively, **cost efficiency** refers to a firm's ability to produce a certain level of output at the lowest possible cost. The cost minimization criterion is more widely used in empirical applications because it represents allocative efficiency in a production process that identifies the least-cost combination of inputs for producing a given level of output.

To sum up, the concept of technical or cost efficiency refers to a level of output at which all resources are being fully employed to generate the most cost-efficient product or services (output) possible. It is about how efficiently the inputs can be used as a bundle so that, for a given level of output, the optimal combination of resources will lead to the lowest possible cost.

Figure F.1 provides a simple illustration of cost efficiency and technical efficiency using one input and one output. In the left figure, the X-axis typically represents the input quantity and the Y-axis represents the output quantity. The curve represents the cost efficiency frontier. It shows the maximum possible output that can be produced for a given level of input, at the lowest possible cost. Points on the curve represent cost-efficient production points for each level of output. These are scenarios where the firm is producing the maximum output from its inputs at the lowest cost. Points below the curve represent inefficient production points. Here, the firm is either not producing the maximum output from its given inputs or is not doing so at the lowest cost. Similarly in the right figure, the X-axis represents the input quantity, and the Y-axis represents the output quantity. The curve in this figure represents the production possibility frontier or technical efficiency frontier. It shows the maximum possible output that can be achieved with a given level of input, without considering the cost. Points on the curve represent technically efficient production points. In these scenarios, the firm is utilizing its inputs to their fullest potential to maximize output. Points below the curve indicate technical inefficiency. In these cases, the firm is not producing the maximum possible output from its given inputs, but this does not take cost into consideration.

FIGURE F.1 Cost and Technical Efficiency in a One Input and One Output Case



Note: The technical efficiency here, $TE = \frac{y_A}{y_B}$.

Stochastic frontier analysis. Stochastic Frontier Analysis (SFA) is used to estimate production or cost functions, to tease out cost and technical inefficieneces in production. SFA achieves this by employing parametric econometric models to estimate production frontiers and technical and cost (in)efficiencies with respect to these frontiers.

The main advantage of the SFA methodology is its ability to tease out the inefficiency parameter from the error term. In an econometric model, the error term captures the difference between the input–output relationship specified by the model and the actual input–output relationship—in other words, the part of the actual variation in data that the model fails to explain. As a result, one must select the functional form of the frontier in such a way that it minimizes the error. An SFA model can be either a Cobb-Douglas, log-linear, or trans-log stochastic production function. We use a log-linear function instead of a Cobb-Douglas function because our dataset is large, and the Cobb-Douglas form is more appropriate where the sample is small and not many degrees of freedom are needed (Estruch-Juan et al. 2020). Also, with a log–linear model, the input–output relationships (beta coefficient) can be used as elasticities or responsiveness, which can come in handy to policy makers for future programming.

EFFICIENCY ESTIMATION

A stochastic production frontier model with output-oriented technical inefficiency of the i^{th} utility can be specified as

Equation 15

$$\text{Ln}(y_i) = \ln(y_i^*) - u_i; \text{ where, } u_i > 0; \text{ and } (y_i^*) = f(\beta; x_i) + v_i,$$

$$\text{or, } \ln(y_i) - \ln(y_i^*) = -(u_i).$$

Rearranging we get $\ln\left(\frac{y_i}{y_i^*}\right) = -(u_i)$. Or, technical efficiency of the i^{th} utility firm, $\ln\left(\frac{y_i}{y_i^*}\right) = exp(-u_i)$. The cost efficiency can be explained in a similar way.

For our analysis we used the following two SFA models using panel data:

For the technical efficiency estimation:

Equation 16

$$ldy_{i,t} = \beta_0 + \sum_{j=1}^{k} \beta_{kt} x_{kit} + year - u_{it} \text{ ; and}$$

For the cost efficiency estimation:

Equation 17

$$ldc_{i,t} = \beta_0 + \sum_{j=1}^{k} \beta_{kt} x_{kit} + year - u_{it}$$

where, $ldy_{i,t}$ is the log of the value of water production in year t in 2017 international dollars. The value of water production is calculated based on total water produced and the corresponding tariff rate. Alternatively, $ldc_{i,t}$ is the log of the operating cost for year t in 2017 US dollars. The input data for both the models are the log of the sum of the total labor cost, the repair and maintenance cost, electricity cost, contracted service cost, and other costs. We considered 1,599 utilities from 68 countries and their corresponding information for 2004 through 2017, to estimate the Stochastic Production Frontier.

MONETARY EQUIVALENCE OF EFFICIENCY LOSS

The assessment of cost inefficiency loss in monetary terms involves the multiplication of the inefficiency level of each utility by its total cost, denominated in US dollars at 2015 constant prices. This computation is grounded in data encompassing 1,557 utilities from 68 countries on which consistent data is available. Utilities that lack information about their characteristics, such as their size and the type of service they provide, have been excluded going forward in the analysis. For each utility, the monetary equivalence of cost inefficiency is determined by calculating the pooled average of all 14 years from 2004 to 2017. On a country level, the average loss value is derived as the mean of the overall loss in all utilities within that country for all years. The monetary quantification of total efficiency loss, categorized by utility size, region, and service provider type, follows the same approach.

TABLE F.1 Average Efficiency Loss (billion US$) and as a Share of Average Operating Cost (%), by Size, Region, and Service Provider Type

	Size of water utilities	Average monetary value of efficiency loss (in million USD)	Average value of operating cost in (in million USD)	Average monetary value of efficiency loss as percentage of average operating cost	Average cost efficiency (%)	Total number of utilities
Total	Small	0.46	4.96	9%	84%	477
	Medium	5.72	73.68	8%	83%	616
	Large	38.96	216.03	18%	80%	464
	Total	21.38	132.27	16%	82%	1557
By region						
EAP	Small	0.01	7.76	0%	90%	5
	Medium	11.94	159.35	7%	87%	77
	Large	36.21	352.08	10%	82%	82
	Total	19.79	209.47	9%	86%	164
ECA	Small	0.29	2.39	12%	82%	87
	Medium	3.84	21.76	18%	83%	155
	Large	37.24	159.00	23%	77%	163
	Total	17.59	77.17	23%	80%	405
LAC	Small	2.61	21.35	12%	86%	370
	Medium	16.35	112.77	14%	86%	307
	Large	151.76	934.04	16%	81%	108
	Total	73.48	457.46	16%	84%	785
MENA	Small	0.09	0.59	15%	83%	1
	Medium	2.80	15.95	18%	69%	9
	Large	17.23	94.05	18%	81%	11
	Total	9.63	52.80	18%	77%	21
SA	Small	0.00	0.03	14%	86%	2
	Medium	0.38	3.39	11%	87%	22
	Large	14.70	113.62	13%	85%	8
	Total	8.90	68.85	13%	86%	32

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TABLE F.1 Average Efficiency Loss (billion US$) and as a Share of Average Operating Cost (%), by Size, Region, and Service Provider Type ***(continued)***

	Size of water utilities	Average monetary value of efficiency loss (in million USD)	Average value of operating cost in (in million USD)	Average monetary value of efficiency loss as percentage of average operating cost	Average cost efficiency (%)	Total number of utilities
SSA	Small	0.14	0.96	15%	83%	12
	Medium	1.76	133.20	1%	86%	46
	Large	21.88	95.27	23%	82%	92
	Total	14.76	95.69	15%	83%	150
By income group						
High income	Small	0.26	11.02	2%	91%	7
	Medium	21.62	231.51	9%	76%	75
	Large	62.43	458.90	14%	81%	48
	Total	37.92	302.80	13%	81%	130
Upper middle income	Small	0.77	6.43	12%	81%	452
	Medium	5.19	34.32	15%	83%	433
	Large	71.91	358.31	20%	78%	282
	Total	33.05	168.20	20%	80%	1167
Lower middle income	Small	0.07	0.49	14%	84%	17
	Medium	1.53	85.62	2%	87%	106
	Large	10.46	58.49	18%	82%	121
	Total	5.73	56.58	10%	84%	244
Low income	Small	0.03	0.18	14%	84%	1
	Medium	0.07	0.40	18%	82%	2
	Large	2.69	18.06	15%	82%	13
	Total	2.09	14.03	15%	82%	16
By service provider type						
National	Small	0.09	0.54	16%	85%	2
	Medium	0.43	2.92	15%	85%	6
	Large	7.73	42.10	18%	81%	14
	Total	5.28	28.95	18%	83%	22

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TABLE F.1 Average Efficiency Loss (billion US$) and as a Share of Average Operating Cost (%), by Size, Region, and Service Provider Type ***(continued)***

	Size of water utilities	Average monetary value of efficiency loss (in million USD)	Average value of operating cost in (in million USD)	Average monetary value of efficiency loss as percentage of average operating cost	Average cost efficiency (%)	Total number of utilities
Regional	Small	0.41	2.86	14%	84%	67
	Medium	2.62	16.73	16%	83%	96
	Large	52.04	335.16	16%	79%	117
	Total	27.64	178.00	16%	81%	280
Municipal	Small	0.61	7.62	8%	82%	355
	Medium	9.28	89.20	10%	84%	416
	Large	71.46	374.15	19%	79%	233
	Total	32.48	184.91	18%	82%	1004
Unidentified group	Small	0.28	2.37	12%	86%	53
	Medium	5.42	117.54	5%	82%	98
	Large	20.99	109.78	19%	81%	100
	Total	12.63	92.86	14%	82%	251

Note: EAP = East Asia and Pacific; MENA = Middle East and North Africa; SA = South Asia.

SENSITIVITY ANALYSIS

To check whether the imputation of missing values in our dataset biases the results, we estimated cost and technical efficiency at each stage of imputation. To reach to our final dataset of a balanced panel of 1,599 utilities in 68 countries over 14 years (2004–17), we used three stages of imputations. In table F2, columns 1–2 provide cost and technical efficiency models without any imputation. This is based on the available data reported in IBNET. Columns 3–4 provide estimates from forward-looking imputations (based on a 3-year moving average of lag values) and backward-looking imputations (based on a 3-year moving average of lead values). Columns 5–6 provide estimates of cost and technical efficiency for our full sample of a balanced panel with no missing values. In the full-sample balanced panel, we filled out the remaining missing values using the mean values of similar utilities (by type and size) for each year. We classified the utilities based on type of service provider, size of population served, and year. Starting with model 1 with no imputation, models 2, 3, and 4 use the previous model as their starting point for imputation.

The hypothesis for our sensitivity analysis is that imputed input and output values increase bias in the (in)efficiency estimate due to an increase in unobserved heterogeneity. For comparison across each set of estimated models, we used the standard deviation of inefficiency (σ_u) and the standard deviation of the unobserved heterogeneity (θ).

In SFA, these two parameters are estimated in two sequential steps: in the first, the model estimates the parameter θ by maximizing the loglikelihood function. It is time-invariant and originates mainly from variation across unobserved, individual, utility-level factors that do not change over time. In the second step, the model estimates the point estimates of inefficiency (σ_u) through the mean (or the mode) of the distribution of inefficiency conditional on the parameter θ and the composite model error term. We ignore σ_v since the maximum likelihood estimator of σ_v can be biased by the incidental parameter problem for models 1 and 2.

For the models with fewer samples, the issue becomes more important due to the influence of idiosyncratic errors of even a few utilities. This, however, goes down as the number of observations in the panel increases. Moon, Perron, and Phillips (2015) note that the Gaussian maximum likelihood estimation (MLE) is asymptotically biased downward, and that the bias decreases as the time series sample size T increases (Moon, Perron, and Phillips 2015). Since our imputation takes advantage of temporal values of each utility from their own lead and lag values, we expect that this issue will be greater for earlier models with less time series than for the balanced panel with more time series values.

Table F.2 provides the parameter estimates of σ_u and θ. We find that the value of the unobserved heterogeneity increases with an increase in number of observations, particularly for cost efficiency models. It is fairly consistent since it is expected that unobserved time-invariant heterogeneity may increase with an increase in the number of observations. It also assures us that the imputation does not repeat the values across utilities over the year. Given the estimated value of θ, we find that the value of σ_u is fairly consistent across models for both cost and technical efficiency. The sign and values both suggest that no significant bias has been added in our inefficiency estimate due to imputation.

TABLE F.2 Stochastic Frontier Regressions for Cost and Technical Efficiency, with and without Missing Value Imputations

Variables	Definition	No imputation		With imputation (Lead/Lag)		With imputation (mean by categories)	
		Cost eff.	Tech. eff.	Cost eff.	Tech. eff.	Cost eff.	Tech. eff.
		(1)	(2)	(3)	(4)	(5)	(6)
ldc3	Log of electricity/energy cost in international PPP	0.134***	0.056*	0.239***	0.169	0.124***	0.044***
ldc4	Log of repair + maintenance cost in 2017 international PPP	0.135***	0.142	0.096***	−0.011	0.001	−0.004
ldc5	Log of contracted service cost in 2017 international PPP	0.080***	0.063**	0.066***	0.093	0.008**	0.021*
ldc9	Log of labor cost in 2017 international PPP	0.641***	0.439***	0.508***	0.263***	0.015***	0.042***
Time	Time in years (2004–17)	−0.018*	−0.062***	−0.001	−0.073	0.527***	0.202***
Constant	Intercept	1.778***	6.077***	2.592***	8.494	−0.003**	−0.048***
U-sigma	SD of inefficiency	−3.862***	−2.307***	−2.906***	−8.226	−2.669***	−1.592***
V-sigma	SD of idiosyncratic error	−2.475***	−2.688***	−2.310***	−1.483	1.764***	3.243***
Theta	SD of unobserved heterogeneity	0.416***	2.307***	0.851***	2.510	4.993***	10.856***
Observations	Number of observations in the balanced panel	1,079	832	5,894	3,920	22,043	22,043
Number of utilities	Number of utilities in the sample	322	239	421	280	1,599	1,599

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APPENDIX G

Country-Level Estimations of Infrastructure Capital Expenditure, Water and WSS Total Expenditure and Capital Expenditure

TABLE G.1 Estimating Infrastructure Capital Spending Comparison of the List of Countries

Region	BOOST countries (available as of 2021/10)	BOOST countries in (Fay et al. 2019)	69 BOOST countries in Part 2, Chapter 1	68 BOOST countries in Part 3, Chapter 1-3
SSA	Angola	Angola	Angola	Angola
	Benin	Benin	Benin	Benin
	Burkina Faso	Burkina Faso	Burkina Faso	Burkina Faso
	Burundi	Burundi	Burundi	Cabo Verde
	Cabo Verde	Cabo Verde	Cabo Verde	Cameroon
	Cameroon	Cameroon	Cameroon	
	Ethiopia	Ethiopia	Ethiopia	Ethiopia
	Gabon	Gabon	Gabon	
	Gambia, The	Guinea	Gambia, The	Gambia, The
	Guinea		Guinea	Guinea
	Guinea-Bissau	Guinea-Bissau	Guinea-Bissau	Guinea-Bissau
	Kenya	Kenya	Kenya	Kenya
	Lesotho	Lesotho	Lesotho	Lesotho
	Liberia	Liberia	Liberia	Liberia
	Madagascar		Madagascar	
	Malawi		Malawi	Malawi
	Mali	Mali	Mali	Mali
	Mauritania	Mauritania		Mauritania
	Mauritius	Mauritius	Mauritius	Mauritius
	Mozambique	Mozambique	Mozambique	Mozambique
	Namibia	Namibia	Namibia	Namibia
	Niger	Niger	Niger	Niger

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TABLE G.1 Estimating Infrastructure Capital Spending Comparison of the List of Countries *(continued)*

Region	BOOST countries (available as of 2021/10)	BOOST countries in (Fay et al. 2019)	69 BOOST countries in Part 2, Chapter 1	68 BOOST countries in Part 3, Chapter 1-3
	Rwanda		Rwanda	
	Sao Tome and Principe[a]	Sao Tome and Principe		
	Senegal	Senegal	Senegal	Senegal
	Seychelles		Seychelles	
	Sierra Leone	Sierra Leone	Sierra Leone	Sierra Leone
	South Africa		South Africa	South Africa
	Tanzania	Tanzania	Tanzania	Tanzania
	Togo	Togo	Togo	Togo
	Uganda	Uganda	Uganda	Uganda
EAP	Fiji	Fiji	Fiji	Fiji
	Indonesia	Mongolia	Indonesia	Indonesia
	Kiribati			
	Mongolia		Mongolia	Mongolia
	Myanmar	Myanmar	Myanmar	Myanmar
	Papua New Guinea			Papua New Guinea
	Solomon Islands			Solomon Islands
	Timor-Leste			Timor-Leste
ECA	Albania	Albania	Albania	Albania
	Armenia	Armenia	Armenia	Armenia
	Bulgaria	Bulgaria	Bulgaria	Bulgaria
	Croatia		Croatia	Croatia
	Georgia		Georgia	Georgia
	Kosovo			Kosovo
	Kyrgyz Republic	Kyrgyz Republic		
	Moldova	Macedonia, FYR	Moldova	Moldova
	North Macedonia	Moldova	North Macedonia	North Macedonia
	Poland	Poland	Poland	Poland
	Romania		Romania	Romania
	Tajikistan	Tajikistan	Tajikistan	
	Ukraine	Ukraine	Ukraine	Ukraine

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TABLE G.1 Estimating Infrastructure Capital Spending Comparison of the List of Countries *(continued)*

Region	BOOST countries (available as of 2021/10)	BOOST countries in (Fay et al. 2019)	69 BOOST countries in Part 2, Chapter 1	68 BOOST countries in Part 3, Chapter 1-3
LAC	Argentina		Argentina	Argentina
	Bahamas, The		Bahamas, The	
	Brazil	Brazil	Brazil	Brazil
	Chile	Chile	Chile	Chile
	Costa Rica	Costa Rica	Costa Rica	Costa Rica
	Dominican Republic	Dominican Republic	Dominican Republic	Dominican Republic
	Ecuador		Ecuador	Ecuador
	El Salvador	El Salvador	El Salvador	El Salvador
	Guatemala	Guatemala		Guatemala
	Guyana		Guyana	
	Haiti	Haiti	Haiti	Haiti
	Jamaica			Jamaica
	Mexico	Mexico	Mexico	Mexico
	Nicaragua		Nicaragua	Nicaragua
	Panama		Panama	Panama
	Paraguay	Paraguay	Paraguay	Paraguay
	Peru	Peru	Peru	Peru
	St. Lucia	St. Lucia	St. Lucia	
	Trinidad and Tobago	Trinidad and Tobago		Trinidad and Tobago
	Uruguay	Uruguay	Uruguay	Uruguay
MENA	Jordan		Jordan	Jordan
	Lebanon			Lebanon
	Oman		Oman	Oman
	Saudi Arabia		Saudi Arabia	Saudi Arabia
	Tunisia	Tunisia	Tunisia	Tunisia
SA	Afghanistan			Afghanistan
	Bangladesh	Bangladesh	Bangladesh	Bangladesh
	Bhutan	Bhutan	Bhutan	

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TABLE G.1 Estimating Infrastructure Capital Spending Comparison of the List of Countries *(continued)*

Region	BOOST countries (available as of 2021/10)	BOOST countries in (Fay et al. 2019)	69 BOOST countries in Part 2, Chapter 1	68 BOOST countries in Part 3, Chapter 1-3
	Maldives		Maldives	
	Pakistan	Pakistan	Pakistan	Pakistan

Note: (1) There were 82 countries available in BOOST database as of November 2021; (2) 69 countries are included in the replicating and predicting model of part 2, chapter 1. Countries without CE (civil engineering) or GG (general government) information were excluded automatically in the regression model; (3) A total of 68 countries were included in part 2, chapter 1 after applying linear interpolation to compute missing values. Countries with less than 5 years' worth of budget data available were excluded in the interpolation procedure. EAP = East Asia and Pacific; MENA = Middle East and North Africa; SA = South Asia.
a. Excluded from all analysis due to low data quality.

TABLE G.2 Infrastructure Capital Spending, by Methodology

Country	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI)	Method 2estimate: (BOOST + PPI or Minimum of two GFCFs)	Method 3 estimate: (0.9*GFCF_CE)	Method 4 Estimate: Refinement Augmented with SOE
Angola	3.03	3.03	13.17	4.22
Benin	1.03	1.03	2.36	1.36
Botswana	2.34	7.35	8.68	3.24
Burkina Faso	1.62	1.62	6.87	2.15
Burundi	0.54	0.54	2.12	0.75
Cabo Verde	2.47	2.47	4.51	3.30
Cameroon	0.95	0.95	2.63	1.30
Central African Republic	1.83	1.99	1.80	2.55
Chad	1.42	1.83	1.66	1.94
Comoros	1.73	1.52	1.37	2.41
Congo, Dem. Rep.	1.79	2.96	7.54	2.50
Congo, Rep.	4.94	6.17	26.68	6.62
Cote d'Ivoire	1.41	1.93	1.75	1.87
Equatorial Guinea	1.64	2.39	2.16	2.28
Eswatini	1.49	0.06	0.05	2.08
Ethiopia	3.66	3.66	19.13	5.10

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TABLE G.2 Infrastructure Capital Spending, by Methodology *(continued)*

Country	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI)	Method 2estimate: (BOOST + PPI or Minimum of two GFCFs)	Method 3 estimate: (0.9*GFCF_CE)	Method 4 Estimate: Refinement Augmented with SOE
Gabon	2.03	2.03	12.60	2.67
Gambia, The	3.46	3.46	1.18	4.83
Ghana	1.82	2.08	1.88	2.22
Guinea	2.33	2.33	1.17	3.20
Guinea-Bissau	1.73	1.73	0.15	2.41
Kenya	3.75	3.75	3.51	5.12
Lesotho	4.09	4.09	3.92	5.71
Liberia	2.13	2.13	6.84	2.40
Madagascar	0.46	0.46	1.29	0.57
Malawi	0.48	0.48	0.85	0.67
Mali	1.59	1.59	2.13	2.14
Mauritania	0.45	0.45	4.94	0.63
Mauritius	0.87	0.87	8.45	1.08
Mozambique	2.97	2.97	8.36	3.99
Namibia	1.36	1.36	2.08	1.88
Niger	1.51	1.51	2.87	2.11
Nigeria	1.03	1.25	1.13	1.39
Rwanda	2.93	2.93	2.22	3.81
São Tomé and Príncipe	2.62	6.28	5.68	3.66
Senegal	2.66	2.66	3.87	3.31
Seychelles	0.28	0.28	6.84	0.39
Sierra Leone	2.24	2.24	1.51	2.96
South Africa	1.98	1.98	4.76	2.60
Sudan	0.80	0.16	0.14	1.12
Tanzania	1.65	1.65	2.73	2.30
Togo	3.09	3.09	5.06	3.92
Uganda	1.65	1.65	1.24	2.24

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TABLE G.2 Infrastructure Capital Spending, by Methodology *(continued)*

Country	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI)	Method 2estimate: (BOOST + PPI or Minimum of two GFCFs)	Method 3 estimate: (0.9*GFCF_CE)	Method 4 Estimate: Refinement Augmented with SOE
Zambia	1.87	1.82	1.65	2.38
Zimbabwe		1.35	1.22	
Cambodia	2.57	1.89	1.71	3.38
China	2.36	12.71	11.50	3.86
Fiji	3.06	3.06	0.28	4.97
Indonesia	0.90	0.90	12.94	1.29
Kiribati	0.59	0.59		0.98
Lao PDR		5.44	4.92	
Malaysia	1.68	5.76	5.21	2.62
Mongolia	2.87	2.87	2.37	4.53
Myanmar	1.61	1.61	3.80	2.59
Papua New Guinea	1.94	1.94		3.19
Philippines	1.70	3.53	3.19	2.32
Solomon Islands	1.20	1.20		1.97
Thailand	1.47	3.90	3.53	2.15
Timor-Leste	6.67	6.67		10.97
Viet Nam	1.98	5.63	6.93	2.99
Albania	4.03	4.03	6.42	5.42
Armenia	2.59	2.59	3.50	3.25
Azerbaijan	1.80	5.40	6.52	2.85
Belarus		5.20	4.70	
Bosnia and Herzegovina	1.74	2.90	2.62	2.54
Bulgaria	2.44	2.44	2.93	3.61
Croatia	0.50	0.50	2.95	0.79
Cyprus	1.24	1.37	1.24	1.97
Czech Republic	0.93	2.34	2.12	1.47
Georgia	2.72	2.72	3.11	3.88

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TABLE G.2 Infrastructure Capital Spending, by Methodology *(continued)*

Country	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI)	Method 2estimate: (BOOST + PPI or Minimum of two GFCFs)	Method 3 estimate: (0.9*GFCF_CE)	Method 4 Estimate: Refinement Augmented with SOE
Greece	1.08	3.08	2.78	1.72
Hungary	1.18	3.52	3.18	1.87
Kazakhstan	1.01	2.15	3.02	1.60
Kosovo	5.51	5.51		8.22
Kyrgyz Republic	0.55	0.55	9.77	0.83
Moldova	1.80	1.80	1.88	2.81
Montenegro	3.00	7.95	9.24	4.50
North Macedonia	1.18	1.18	2.78	1.69
Poland	1.01	1.01	2.96	1.60
Romania	1.99	1.99	3.01	2.99
Russian Federation	1.31	2.77	4.99	1.97
Serbia	1.58	2.57	3.25	2.31
Tajikistan	1.53	1.53	8.16	2.25
Türkiye	1.72	3.16	2.85	2.20
Ukraine	0.93	0.93	2.55	1.28
Uzbekistan		2.42		
Argentina	1.03	1.03	3.68	1.29
Bahamas, The	0.70	0.70	1.91	0.89
Belize	2.01	1.73	1.56	2.48
Bolivia	1.77	3.85	3.49	2.26
Brazil	1.06	1.06	1.49	1.10
Chile	0.88	0.88	5.20	1.12
Colombia	2.01	4.30	4.78	2.33
Costa Rica	1.90	1.90	2.73	2.33
Dominica	3.01	8.75	7.92	3.84
Dominican Republic	2.19	2.19	1.32	2.75
Ecuador	1.21	1.21	13.06	1.51

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TABLE G.2 Infrastructure Capital Spending, by Methodology *(continued)*

Country	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI)	Method 2estimate: (BOOST + PPI or Minimum of two GFCFs)	Method 3 estimate: (0.9*GFCF_CE)	Method 4 Estimate: Refinement Augmented with SOE
El Salvador	0.92	0.92	2.12	1.13
Grenada	1.81	1.32	1.19	2.26
Guatemala	2.23	2.23		2.75
Guyana	1.75	1.75	5.61	2.23
Haiti	0.45	0.45	0.00	0.56
Honduras	3.06	4.02	3.63	3.46
Jamaica	2.20	2.20	2.15	2.43
Mexico	2.82	2.82	2.92	3.49
Nicaragua	2.33	2.33	2.96	2.76
Panama	2.33	2.33	8.55	2.96
Paraguay	2.07	2.07	3.80	2.64
Peru	3.29	3.29	3.74	3.85
St. Kitts and Nevis	1.70	1.71	1.55	2.17
St. Lucia	1.30	1.30	0.04	1.61
St. Vincent and the Grenadines	1.92	1.27	1.15	2.45
Suriname		1.88	1.70	
Trinidad and Tobago	0.75	0.75	1.03	0.95
Uruguay	0.33	0.33	3.32	0.42
Venezuela, RB		8.92		
Algeria	2.17	8.52	9.96	3.26
Bahrain	1.42	3.67	3.32	2.16
Djibouti	2.50	5.77	8.69	3.79
Egypt, Arab Rep.	1.17	3.07	2.77	1.69
Iran, Islamic Rep.	0.96	2.22	3.98	1.46
Iraq	1.53	4.74	4.29	2.24
Jordan	2.63	2.63	0.73	3.05

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TABLE G.2 Infrastructure Capital Spending, by Methodology *(continued)*

Country	Method 1 estimate: (OLS fitted values and Actual BOOST + PPI)	Method 2estimate: (BOOST + PPI or Minimum of two GFCFs)	Method 3 estimate: (0.9*GFCF_CE)	Method 4 Estimate: Refinement Augmented with SOE
Lebanon	0.37	0.37		0.55
Morocco	2.24	5.96	5.63	3.03
Oman	1.74	1.74	7.82	2.64
Saudi Arabia	1.26	1.26	2.02	1.91
Tunisia	1.62	1.62	3.63	2.44
Yemen, Rep.		0.57		
Afghanistan	2.09	2.09		3.19
Bangladesh	1.36	1.36	3.02	2.00
Bhutan	7.14	7.14	22.98	10.69
India	1.87	5.68	5.14	2.52
Maldives	4.18	4.18	13.53	6.38
Nepal	2.13	5.00	5.61	3.04
Pakistan	0.73	0.73	1.98	0.86
Sri Lanka	1.41	3.70	3.35	2.05

Note: World Bank elaboration based on BOOST database. GG = general government; CE = civil engineering. PPI = private participation infrastructure.
a. Some countries have missing values in method 1 due to the unavailability of GG or CE.

TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Angola	3.01	0.44	0.48	0.04	0.32	0.35	0.03
Benin	0.83	0.12	0.20	0.08	0.12	0.19	0.07
Botswana	2.28	0.37	0.52	0.15	0.22	0.35	0.12
Burkina Faso	1.35	0.31	0.31	0.00	0.26	0.26	0.00
Burundi	0.54	0.08	0.08	0.00	0.02	0.02	0.00
Cabo Verde	2.10	0.17	0.31	0.14	0.08	0.12	0.04
Cameroon	0.88	0.02	0.03	0.01	0.02	0.02	0.00
Central African Republic	1.83	0.31	0.44	0.13	0.21	0.29	0.08
Chad	1.29	0.15	0.24	0.09	0.16	0.23	0.08
Comoros	1.73	0.22	0.34	0.12	0.19	0.26	0.07
Congo, Dem. Rep.	1.79	0.23	0.32	0.09	0.18	0.26	0.09
Congo, Rep.	4.23	0.46	0.62	0.15	0.26	0.36	0.10
Cote d'Ivoire	1.17	0.21	0.30	0.09	0.17	0.26	0.09
Equatorial Guinea	1.64	0.33	0.47	0.14	0.21	0.33	0.12
Eswatini	1.49	0.27	0.39	0.12	0.20	0.28	0.08

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector *(continued)*

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Ethiopia	3.65	0.42	0.44	0.01	0.22	0.22	0.00
Gabon	1.62	0.14	0.15	0.01	0.14	0.14	0.00
Gambia, The	3.46	0.26	0.27	0.01	0.35	0.35	0.00
Ghana	1.02	0.13	0.20	0.07	0.15	0.23	0.08
Guinea	2.20	0.41	0.55	0.14	0.28	0.38	0.10
Guinea-Bissau	1.73	0.21	0.32	0.12	0.20	0.27	0.07
Kenya	3.46	0.41	0.52	0.10	0.32	0.39	0.07
Lesotho	4.09	0.83	1.39	0.56	0.83	1.39	0.56
Liberia	0.66	0.17	0.17	0.00	0.06	0.07	0.02
Madagascar	0.28	0.05	0.08	0.03	0.05	0.08	0.03
Malawi	0.48	0.17	0.53	0.36	0.10	0.37	0.27
Mali	1.38	0.29	0.29	0.01	0.03	0.03	0.00
Mauritania	0.45	0.06	0.06	0.00	0.06	0.06	0.00
Mauritius	0.53	0.10	0.26	0.16	0.10	0.21	0.11
Mozambique	2.58	0.59	0.87	0.28	0.53	0.75	0.22
Namibia	1.32	0.33	0.49	0.16	0.32	0.45	0.13

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector *(continued)*

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Niger	1.51	0.32	0.37	0.05	0.30	0.33	0.03
Nigeria	0.90	0.09	0.09	0.00	0.11	0.11	0.00
Rwanda	2.22	0.27	0.33	0.06	0.26	0.32	0.06
Sao Tome and Principe	2.62	0.40	0.56	0.17	0.25	0.32	0.08
Senegal	1.64	0.13	0.20	0.06	0.10	0.13	0.03
Seychelles	0.28	–	–	–	–	–	–
Sierra Leone	1.83	0.11	0.17	0.06	0.10	0.16	0.06
South Africa	1.59	0.34	0.50	0.15	0.34	0.50	0.15
Sudan	0.80	0.08	0.14	0.06	0.13	0.21	0.08
Tanzania	1.65	0.07	0.50	0.43	0.05	0.48	0.43
Togo	2.09	0.07	0.12	0.04	0.07	0.12	0.04
Uganda	1.51	0.10	0.17	0.07	0.08	0.15	0.07
Zambia	1.29	0.23	0.33	0.10	0.18	0.26	0.09
Zimbabwe	–	–	–	–	–	–	–
Cambodia	1.25	0.19	0.30	0.10	0.17	0.23	0.06
China	2.32	0.62	0.68	0.06	0.25	0.29	0.03

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector *(continued)*

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Fiji	2.97	0.71	0.75	0.04	0.59	0.60	0.01
Indonesia	0.60	0.11	0.17	0.06	0.05	0.11	0.06
Kiribati	0.59	–	–	–	–	0.50	–
Lao PDR	–	–	–	–	–	–	–
Malaysia	1.47	0.35	0.49	0.14	0.20	0.31	0.11
Mongolia	2.57	0.41	0.56	0.15	0.30	0.38	0.08
Myanmar	1.52	0.55	0.79	0.24	0.11	0.13	0.02
Papua New Guinea	1.94	0.33	0.33	0.00	0.27	0.30	0.04
Philippines	0.96	0.18	0.26	0.08	0.15	0.22	0.07
Solomon Islands	1.20	0.39	0.67	0.27	–	0.21	–
Thailand	1.06	0.24	0.36	0.11	0.17	0.28	0.10
Timor-Leste	6.67	0.67	1.40	0.73	0.03	0.07	0.04
Viet Nam	1.56	0.28	0.38	0.10	0.19	0.26	0.08
Albania	2.37	0.73	0.88	0.16	0.57	0.66	0.09
Armenia	1.15	0.47	0.82	0.35	0.23	0.38	0.15
Azerbaijan	1.80	0.29	0.46	0.17	0.20	0.28	0.09

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TABLE G.3 **Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector** ***(continued)***

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Belarus	–	–	–	–	–	–	–
Bosnia and Herzegovina	1.37	0.19	0.35	0.16	0.17	0.25	0.08
Bulgaria	2.00	0.43	0.51	0.08	0.42	0.49	0.07
Croatia	0.50	0.02	0.48	0.46	0.05	0.32	0.27
Cyprus	1.24	0.21	0.37	0.16	0.17	0.25	0.08
Czech Republic	0.93	0.18	0.32	0.13	0.16	0.24	0.09
Georgia	1.98	0.08	0.13	0.04	0.08	0.13	0.04
Greece	1.08	0.23	0.37	0.14	0.17	0.26	0.09
Hungary	1.18	0.23	0.38	0.15	0.17	0.26	0.09
Kazakhstan	1.01	0.16	0.29	0.13	0.15	0.23	0.09
Kosovo	4.63	0.10	0.11	0.01	0.10	0.11	0.01
Kyrgyz Republic	0.49	0.07	0.30	0.23	0.00	0.00	0.00
Moldova	1.72	0.17	0.24	0.07	0.17	0.21	0.04
Montenegro	2.56	0.39	0.60	0.21	0.24	0.32	0.08
North Macedonia	0.87	0.21	0.23	0.02	0.20	0.22	0.02
Poland	1.01	0.02	0.05	0.03	0.01	0.02	0.02

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector ***(continued)***

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Romania	1.71	0.03	0.36	0.33	0.05	0.23	0.18
Russian Federation	1.14	0.13	0.14	0.00	0.11	0.11	0.00
Serbia	1.26	0.17	0.31	0.14	0.16	0.24	0.08
Tajikistan	1.24	0.05	0.17	0.12	–	–	–
Türkiye	0.82	0.20	0.33	0.13	0.15	0.25	0.10
Ukraine	0.59	0.01	0.02	0.01	0.01	0.02	0.01
Uzbekistan	–	–	–	–	–	–	–
Argentina	0.96	0.30	0.58	0.28	0.30	0.57	0.27
Bahamas, The	0.70	0.14	0.52	0.38	0.05	0.50	0.45
Belize	1.74	0.26	0.58	0.32	0.20	0.41	0.21
Bolivia	1.77	0.43	0.76	0.33	0.24	0.47	0.23
Brazil	0.13	0.04	0.05	0.01	0.03	0.04	0.00
Chile	0.88	0.11	0.13	0.02	0.07	0.09	0.02
Colombia	1.17	0.21	0.50	0.29	0.16	0.42	0.26
Costa Rica	1.59	0.18	0.81	0.63	0.13	0.60	0.47
Dominica	3.01	0.52	0.93	0.41	0.29	0.53	0.25

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector *(continued)*

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Dominican Republic	2.04	0.52	1.39	0.88	0.20	0.83	0.63
Ecuador	1.11	0.00	0.08	0.07	0.00	0.02	0.02
El Salvador	0.78	0.11	0.35	0.24	0.01	0.34	0.33
Grenada	1.64	0.18	0.51	0.33	0.18	0.41	0.23
Guatemala	1.90	0.30	0.56	0.26	0.27	0.37	0.10
Guyana	1.75	0.36	0.58	0.22	0.30	0.30	0.00
Haiti	0.37	0.04	0.05	0.02	0.03	0.04	0.01
Honduras	1.49	0.22	0.52	0.29	0.18	0.40	0.22
Jamaica	0.87	0.01	0.08	0.07	0.01	0.04	0.03
Mexico	2.46	0.11	0.26	0.15	0.09	0.20	0.10
Nicaragua	1.55	0.12	0.16	0.04	0.12	0.15	0.03
Panama	2.33	0.23	0.62	0.39	0.19	0.51	0.32
Paraguay	2.07	0.11	0.22	0.12	0.08	0.12	0.05
Peru	2.03	0.80	0.80	0.00	0.57	0.57	0.00
St. Kitts and Nevis	1.70	0.19	0.52	0.33	0.18	0.41	0.23

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector ***(continued)***

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
St. Lucia	1.14	0.19	0.52	0.33	0.15	0.38	0.23
St. Vincent and the Grenadines	1.92	0.31	0.67	0.36	0.22	0.46	0.24
Suriname	–	–	–	–	–	–	–
Trinidad and Tobago	0.75	0.12	1.68	1.56	0.10	1.53	1.43
Uruguay	0.33	0.04	0.06	0.03	0.00	0.00	0.00
Venezuela, RB	–	–	–	–	–	–	–
Algeria	2.11	0.40	0.54	0.13	0.22	0.31	0.08
Bahrain	1.42	0.24	0.37	0.13	0.18	0.27	0.09
Djibouti	2.50	0.34	0.49	0.15	0.22	0.28	0.06
Egypt, Arab Rep.	0.99	0.19	0.28	0.09	0.16	0.23	0.07
Iran, Islamic Rep.	0.96	0.16	0.23	0.07	0.15	0.22	0.07
Iraq	1.39	0.31	0.44	0.13	0.19	0.30	0.10
Jordan	0.81	0.07	0.09	0.01	0.15	0.19	0.04
Lebanon	0.34	0.04	0.06	0.02	0.02	0.02	0.00
Morocco	1.53	0.27	0.38	0.11	0.19	0.26	0.07

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TABLE G.3 Predictions of Total Expenditure, Capital Expenditure and Recurrent Expenditure in the Water Sector and the WSS Subsector *(continued)*

Country	Infrastructure capital expenditure	Water capital expenditure	Water total spending	Water total recurrent	WSS capital expenditure	WSS total spending	WSS total recurrent
Oman	1.74	0.29	0.39	0.11	0.06	0.13	0.07
Saudi Arabia	1.26	0.79	1.20	0.41	0.74	1.12	0.38
Tunisia	1.60	0.45	0.62	0.18	0.25	0.43	0.18
Yemen, Rep.	–	–	–	–	–	–	–
Afghanistan	2.08	0.03	0.04	0.01	0.02	0.03	0.01
Bangladesh	1.21	0.12	0.22	0.10	0.12	0.20	0.09
Bhutan	6.72	0.87	1.05	0.17	0.60	0.75	0.14
India	1.22	0.22	0.22	0.00	0.14	0.14	0.00
Maldives	4.18	1.12	1.15	0.03	0.14	0.17	0.03
Nepal	1.71	0.26	0.38	0.12	0.19	0.25	0.06
Pakistan	0.24	0.06	0.09	0.03	0.04	0.06	0.02
Sri Lanka	1.22	0.20	0.30	0.10	0.17	0.23	0.07

Note: World Bank elaboration based on BOOST database; if infrastructure capital expenditure is missing in refinement 1 from the previous table, then there is no possibility to predict water and WSS expenditure based on this approach. PPI = private participation infrastructure; WSS = water supply and sanitation.
a. Prediction based on refinement 1 but without including PPI.

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