HOW TO

NOTES

How to Assess Spending Needs of the Sustainable Development Goals

The Third Edition of the IMF SDG Costing Tool

NOTE 23/05

How to Assess Spending Needs of the Sustainable Development Goals:
The Third Edition of the IMF SDG Costing Tool
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How to Assess Spending Needs of the Sustainable Development Goals

The Third Edition of the IMF SDG Costing Tool

Prepared by Piergiorgio Carapella, Tewodaj Mogues, Julieth Pico-Mejía, and Mauricio Soto
December 2023

This note contains a technical overview and description of the third edition of the IMF Sustainable Development Goal (SDG) costing tool that estimates the additional spending needs to achieve a strong performance in selected SDGs for human capital development (health and education) and physical capital development (infrastructure)—in particular, water and sanitation, electricity, and roads. The World Bank and UNICEF developed the water and sanitation tool; the IMF formatted and structured it for ease of use and updated its underlying general variables. The Expenditure Policy Division of the IMF's Fiscal Affairs Department developed the other four tools. This note focuses on the third edition, or vintage, of the tools, completed in late 2022. The first edition was finalized in 2018 and is reflected in analysis published in January 2019 in Gaspar and others (2019), which also contains the key outlines of the SDG costing methodology. The second vintage, completed in August 2019, was the basis on which a training session was provided and made open to all IMF staff.[1]

A. Introduction

This note focuses on providing the technical details underlying the third edition estimates of the IMF SDG costing tool and presents the methodological features separately for each of the five SDGs—though some features are common across SDGs—and presents the data sources used. It also provides summary results from the desk estimates of the third edition.

The third edition includes data and methodological updates (while generally remaining faithful to the approach described in Gaspar and others 2019)[2] in various respects. It expands the number of countries from 155 to 173, uses the latest available observations for key variables mostly pertaining to 2020 (previously, data were mostly from 2016), refines the health estimates by accounting for the cost implications of populations' age structure,

[1] Additional costing estimations were undertaken for specific purposes, for example, in the April 2021 Fiscal Monitor (IMF 2021).

[2] The Gaspar and others (2019) methodology assumes that performance is a function of a set of input variables. For the social sectors (health and education), it identifies the median level of inputs for countries that perform well today, with performance measured by SDG index scores. Then, for each country additional spending in 2030 is the difference between spending today and spending in 2030, the latter derived by assigning these input levels and controlling for other factors such as demographics and the level of GDP per capita projected in 2030. For physical capital, additional spending in percentage points of GDP corresponds to the annualized spending required to close infrastructure gaps between today and 2030.

uses new IMF estimates on road quality in determining the length of all-season roads, and offers several other refinements and updates.[3]

The tool focuses on SDGs that make up a significant proportion of countries' budgets and are at the core of inclusive and sustainable growth. We assess the additional spending needed in 2030 relative to a baseline of today's spending, expressed in percentage points of GDP. All reference to expenditures and inputs always pertain to the combined amounts of public and private resources, unless otherwise specified. In each of the five SDGs, the methodology benchmarks a country's 2030 target levels of inputs to current levels of strongly performing peers and/or to SDG-related targets. A country's 2030 target levels of infrastructure and service provision and the associated spending are also informed by 2030 projections of various factors, such as the country's population size, rural–urban composition, demographic distribution, and GDP. Table 1 summarizes all general (that is, non-sector-specific) data used across all five SDG cost estimations.

Table 1. General (Nonsectoral) Variables and Data Sources Used in the SDG Costing Estimation

Variable	Computation or Data Source
Population in 2020 and 2030	2022 *UN World Population Prospects*
Rural population	2018 *UN World Urbanization Prospects*
GDP 2020 (nominal US$)	April 2022 *World Economic Outlook*
GDP 2030 (in 2020 US$)	GDP 2020 * real growth factor of GDP
Real growth factor of GDP (growth from 2020 to 2030)	Y_2020 * Y_2021 * Y_2022 * Y_2023 * Y_2024 * Y_2025 * Y_2026 ^ 5
Annual real GDP growth rate, Y_[t]	$(GDP_t / GDP_{t-1}) - 1$
GDP in year t (in 2020 US$), GDP_t, $t \leq 2022$	October 2022 *World Economic Outlook*

B. Human Capital Development

B.1. Benchmarking and Structure of Additional Spending in Health and Education

B.1.a. Identification of Income Peers and Strong Performers

For the SDG cost assessment in the social sectors (health and education), the target values of a country's cost drivers are benchmarked to those of highly performing income peers. We next illustrate the definition of a country's income peers and present the high performers among these peers. To identify the peers of country *i* for which the SDG's additional spending needs are estimated, countries are classified into three income baskets, based on the three-year average of their GDP per capita from 2018 to 2020.[4] The lowest income basket consists of countries with a three-year average GDP per capita below $4,000, the middle basket ranges from $4,000 to $7,000, and the highest from $7,000 to $20,000. The upper threshold of the lowest bracket is chosen to ensure that all countries included in the IMF low-income developing countries (LIDC) income group fall into the first group; specifically, this threshold is equal to the GDP per capita of the highest-income LIDC,

[3] The IMF SDG costing tool—in this as well as previous editions—focuses on assessing the additional spending needs for selected SDGs and does not explore options on how these spending needs can be financed. Analysis of financing needs, with a special focus on the pandemic's implications, is carried out in Benedek and others (2021). The model underlying the latter uses the SDG costing tool's estimates in its dynamic macroeconomic framework for four case study countries.

[4] GDP per capita for 2018 and 2019 are expressed in 2020 prices.

rounded up to the nearest thousand US dollars. The upper threshold of the second bracket is the median GDP per capita of countries falling into the IMF emerging market economy (EME) income group, rounded to the nearest thousand US dollars. Finally, the upper threshold of the third basket is the 90th percentile of GDP per capita for EMEs, rounded to the nearest thousand USdollars. A country's peers will be determined based on its projected income at the time of the SDG goal year.[5]

Within each basket, the best performers are defined as those countries that achieve an SDG 3 index (in the case of health) or SDG 4 index (in the case of education) above the basket-specific threshold score. These threshold scores are selected so as to obtain about seven good performers per basket. In particular, the threshold score for a given basket is that of the score of the seventh-best performer, rounded to the nearest integer value for the score. As a result, the number of good performers in a given basket may be somewhat higher or lower than seven. Each country *i* to be costed, then, is benchmarked against these top performers among its income peers. Countries with a GDP per capita above $20,000 are benchmarked against good performers in the third (highest) income basket.

B.1.b. Expenditure Needs as a Function of Benchmarked and Projected Factors

Expenditures related to the social sector SDGs in country *i* as a percentage of GDP, Ep_i, can be expressed as a function of direct cost drivers z_i that are benchmarked, such as the number of service providers and their salaries, and as a function of other factors (x_i) influencing the cost of providing health services, such as demographic structure—that is, $Ep_i = f(z_i, x_i)$. The benchmarking draws on today's average levels of the cost drivers of well-performing income peers, z_j^*—that is, of countries sharing the same income basket *j* with country *i* but that have high scores on the sectoral SDG index, in the manner described previously. Then, the 2030 expenditure in country *i* as a percent of 2030 GDP, given z_j^* and the values of other factors that we project for 2030 in country *i*, is estimated as:

$$Ep_{ij}^T = f(z_j^{t0*}, x_{ij}^T) \tag{1}$$

where T refers to the end-year for the SDGs, 2030, and t_0 is the current year (or most recent year for which data are available). Additional spending in 2030 to achieve a high performance, as a percent of 2030 GDP, is then:

$$Ep_{add,ij}^T = Ep_{ij}^T - Ep_{ij}^{t0}$$

The additional spending needs can also be expressed in (constant) dollars:

[5] For example, if a country's 2030 GDP per capita is $4,100, its peers are considered the countries in the middle basket.

$$Ed_{add,i}^{T} = gdp_i^T \cdot Ep_{add,i}^{T} \frac{def_i^{t0}}{def_i^{T}} \qquad (2)$$

where *def*^{t0} and *def*^{T} refer to the deflators for the current period and 2030, respectively, and gdp_i^T refers to country *i*'s 2030 GDP.

B.2. Health (SDG 3)

B.2.a. Performance Thresholds and Estimation of Additional Expenditure Needs

In the case of the health goal, the SDG 3 index thresholds for the lowest, middle, and highest baskets are 75, 79, and 86, resulting in 5, 6, and 6 good performers, respectively. The direct cost drivers in the health sector that are benchmarked to the highly performing peers, z_j^{h*}, include the number of doctors relative to the population size, doctors' salaries (relative to average income), and the share of spending on other areas of health. Other factors, x_i^h, include the demographic distribution affecting the intensity of use of health services, reflected in the share of the population under 1 year old and age 60 and above.

Country i's health expenditures as a percent of GDP in 2030, $Ep_i^{h,T}$, is derived based on the logic of an identity. Under this logic, total health expenditure can be expressed as:

$$Ep_i^h = 10 \cdot wr_i^h \frac{Dpop_i + \alpha \cdot OMpop_i}{100 - OHsh_i} \qquad (3)$$

where

$$Dpop_i = \frac{D_i}{\frac{pop_i}{1{,}000}} \qquad (4)$$

is the number of doctors (D) per 1,000 population *pop*, and the equivalent applies to other medical personnel ($OMpop$ and OM, respectively). Further, wr refers to the average annual wage of doctors as a ratio to GDP per capita, a is the ratio of other medical personnel's average salaries to doctors' wages (see Section 2.c for its estimation), and $OHsh$ ("other health share") is the percent of capital and other recurrent expenditures in total health spending.

It can be easily shown that (3) forms an identity. Writing out both sides of equation (3):

$$100\frac{HE}{gdp} = 10\frac{w^h}{\frac{gdp}{pop}} \cdot \frac{\frac{D}{\frac{pop}{1{,}000}} + \alpha\frac{OM}{\frac{pop}{1{,}000}}}{100 - 100\frac{OH}{HE}} = 10 \cdot pop\frac{w^h}{gdp} \cdot \frac{\frac{1{,}000}{pop}(D + \alpha \cdot OM)}{100\left(1 - \frac{OH}{HE}\right)}$$

$$= 10 \cdot pop\frac{w^h}{gdp} \cdot \frac{10}{pop} \cdot \frac{D + \alpha \cdot OM}{1 - \frac{OH}{HE}} = 100\frac{w^h}{gdp} \cdot \frac{D + \alpha \cdot OM}{1 - \frac{OH}{HE}} = \frac{100}{gdp} \cdot \frac{hse}{\frac{hse}{HE}} = 100\frac{HE}{gdp}$$

where HE is total expenditure on health, w^h is the average doctor salary, OH ("other health") is spending on health other than on medical staff, and *hse* are health staff related expenditures—all of these in monetary units. Based on (1) and (3), then, expenditures needed in 2030 can be derived as:

$$Ep_{ij}^{h,T} = f\left(z_j^{h*}, x_{ij}^{h,T}\right) = 10 \cdot wr_j^{h*}\frac{Dpop_{ij}^{dem*} + \alpha \cdot OMpop_{ij}^{dem*}}{100 - OHsh_j^*} \quad (5)$$

In addition to wr_j^{h*} and $OHsh_j^*$, also benchmarked to the high performers are the number of doctors and number of other health staff, both per 1,000 people ($Dpop_j^*$ and $OMpop_j^*$, respectively); however, these are subsequently adjusted to account for country *i*'s demographic structure, as a population consisting of a relatively high share of elderly will need more medical resources, all else equal. We elaborate this demographic adjustment next.

B.2.b. Demographic Structure and Population Needs for Service Providers

We conceptualize a disaggregation of the total population of a country into those that are low cost (LC)—that is, they require relatively limited amounts of medical services to maintain a healthy life—and those that are high cost (HC):

$$pop = LC + HC \quad (6)$$

The total number of doctors, D, can accordingly be broken down into the number of doctors (these can be thought of as "doctor-hours") used by the high-cost population, D^{HC}, and the number used by the low-cost population (D^{LC}):

$$D = D^{HC} + D^{LC} \quad (7)$$

Using (7), (4) can now be written as:

$$Dpop = 1{,}000 \frac{D^{HC} + D^{LC}}{pop} \tag{8}$$

The intensity of doctor-use by the high-cost population can be described as:

$$Dpop^{HC} = 1{,}000 \frac{D^{HC}}{HC} \tag{9}$$

or the number of doctors used by the high-cost population per 1,000 high-cost people. The equivalent for the low-cost population is:

$$Dpop^{LC} = 1{,}000 \frac{D^{LC}}{LC} \tag{10}$$

Expanding (8), we get:

$$Dpop = 1{,}000 \frac{D^{HC}}{pop} + 1{,}000 \frac{D^{LC}}{pop} = 1{,}000 \frac{D^{HC}}{HC} \frac{HC}{pop} + 1{,}000 \frac{D^{LC}}{LC} \frac{LC}{pop}$$

We can now substitute (9) and (10) into this equation:

$$Dpop = Dpop^{HC} \cdot \frac{HC}{pop} + Dpop^{LC} \frac{LC}{pop} \tag{11}$$

Based on (6) we express the share of the high- and low-cost populations as:

$$HCsh = \frac{HC}{pop}$$

and

$$LCsh = \frac{LC}{pop}$$

These can then be substituted into (11):

$$Dpop = Dpop^{HC} \cdot HCsh + Dpop^{LC} \cdot LCsh = Dpop^{HC} \cdot HCsh + Dpop^{LC} \cdot (1 - HCsh) \quad (12)$$

We apply a parameter from Clements and others (2015) that establishes the following relationship regarding the intensity in health services usage by the high- and the low-cost population:

$$Dpop^{HC} = 3.2\ Dpop^{LC} \quad (13)$$

Bringing this into (12), and simplifying:

$$\begin{aligned} Dpop &= 3.2 \cdot Dpop^{LC} \cdot HCsh + Dpop^{LC} \cdot (1 - HCsh) = Dpop^{LC} \cdot (3.2 \cdot HCsh + 1 - HCsh) \\ &= Dpop^{LC} \cdot (2.2 \cdot HCsh + 1) \end{aligned} \quad (14)$$

Therefore,

$$Dpop^{LC} = \frac{Dpop}{2.2 \cdot HCsh + 1} \quad (15)$$

We are now able to express the target value for country *i* of the number of doctors per 1,000 people that takes into account both *i*'s demographic structure and the benchmarking on high performers: Based on (14) and (15),

$$Dpop_{ij}^{dem*} = \frac{Dpop_j^{t0*}}{2.2 \cdot HCsh_{ij}^{t0} + 1} \left(2.2 \cdot HCsh_{ij}^{T} + 1\right) \quad (16)$$

where $Dpop_j^{t0*}$ refers to today's mean value of the highly-performing peers' unadjusted number of doctors per 1,000 people, and $HCsh_{ij}^{t0}$ and $HCsh_{ij}^{T}$ refer to country *i*'s current and 2030 share of the high-cost population, respectively.

The analogous process applies to the target value for the number of other medical personnel:

$$OMpop_{ij}^{dem*} = \frac{OMpop_j^{t0*}}{\left(2.2 \cdot HCsh_{ij}^{t0} + 1\right)} \left(2.2 \cdot HCsh_{ij}^{T} + 1\right) \tag{17}$$

(16) and (17) are then used in (5) to arrive at the additional spending needs in SDG 3.

B.2.c. Health-Staff Salary Ratios

To compute the wage ratio of other medical personnel to physicians, a, we use global estimates from Serje and others (2018) on the average salaries (as a ratio to GDP per capita) of (1) physicians, (2) nurses and midwives, and (3) other health workers (Table 2.)

Table 2. Salaries of Doctors and Other Medical Personnel

Type of Health Staff	Average Salary (Ratio to GDP per Capita)	Number of Health Staff
Physicians	wr_D = 4.4	D = 12,375,346
Nurses and midwives	wr_N = 3.6	N = 30,199,490
Other health workers	wr_{OW} = 2.1	OW = 17,398,962

We calculate the average salary of other medical personnel by taking a weighted average of the salaries of nurses/midwives and other health workers, using the total number of personnel of each type as the weight. This weighted average is then divided by the average doctor wages, yielding the wage ratio:

$$\alpha = \frac{\frac{(wr_N \cdot N) + (wr_{OW} \cdot OW)}{N + OW}}{wr_D} = 0.68 \tag{18}$$

B.2.d. Data Sources

Table 3 provides an overview of the data sources for the sectoral variables used in the estimation of additional spending in 2030 to achieve a good performance in SDG 3.

Table 3. Sectoral Variables and Data Sources Used in Costing SDG 3

Variable	Abbreviation	Computation and/or Data Source
SDG3 Index		SDG Index and Dashboards, 2022
Recurrent health expenditure (% of GDP) most recent data	Rec	Health Nutrition and Population Statistics, accessed 2022
Capital health expenditure (% of GDP)	Cap	Health Nutrition and Population Statistics, accessed 2022
Total health spending (% of GDP)	Ep^h	$Rec + Cap$
Medical personnel compensation spending (% of total health spending)	$Comp_{hp}$	WHO World Health Report 2006; Table 1.2 (region averages)
Medical personnel compensation spending (% of GDP)	$Comp_{hp,GDP}$	$Comp_{hp} * Ep_i^h$
Doctors per 1,000 people	$Dpop$	Global Health Workforce Statistics, 2022
Other medical staff per 1,000 people	$OMpop$	Global Health Workforce Statistics, 2022; Formula: $Nurses + Dentists + Pharmacists + All\ others$
Doctor wages (ratio to GDP per capita)	wr^h	$\frac{10 * Comp_{hp,GDP}}{Dpop + 0.68 * OMpop}$
Other recurrent and capital health spending (% of total health spending)	$OHsh$	$100 - Comp_{hp}$
External recurrent health expenditure (% of recurrent health expenditure)	Ext_{rp}	Health Nutrition and Population Statistics, accessed 2022
Domestic general government recurrent health expenditure (% of recurrent health expenditure)	Dom_{rp}	Health Nutrition and Population Statistics, accessed 2022
Private health spending (% of total health spending)	$Priv_{hp}$	$100 - Ext_{rp} - Dom_{rp}$
Public health spending (% of total health spending)	Pub_{hp}	$Ext_{rp} + Dom_{rp}$
Private health spending (% of GDP)	$Priv$	$\frac{Priv_{hp}}{100} * Ep^h$
Public health spending (% of GDP)	Pub	$Ep^h - Priv$
Total health spending per population	${Ep_{pc}}^h$	$\frac{Ep^h}{100} * GDP_{pc}$
High-cost population t (under 1 and 60 & over) a % of total population	HC_{sh}	$\frac{Pop\ under\ 1\ and\ 60^+}{Total\ pop} * 100$

B.3. Education (SDG 4)

The broad methodology of estimating the additional spending needs to achieve a high performance in the education SDG proceeds in a manner analogous to that for the health SDG and as described in Section B.2. The SDG 4 index thresholds for the lowest, middle, and highest baskets are 87, 92, and 97, respectively.

The direct cost drivers that are benchmarked to the highly performing peers, z_j^{e*} (*e* for education), include the number of teachers relative to students and teachers' salaries relative to average income. Other factors x_i^e include the enrollment rate and the student-age population. As in health, country *i*'s education expenditures as a percent of GDP in 2030, $Ep_i^{e,T}$, are derived based on an identity:

$$Ep_i^e = \frac{wr_i^e \cdot enr_i \cdot SAPp_i}{STR_i \cdot (100 - OEsh_i)} \tag{19}$$

where STR is the number students per teacher, wr refers to teacher salaries as a ratio to GDP per capita, *enr* is the gross enrollment rate, $OEsh$ is the share (expressed as a percent) of capital and other recurrent expenditures in total education spending, and $SAPp$ is the school-age population[6] as a percent of the total population.

As before, to see that (19) is an identity, expressing it written out:

$$100\frac{EE}{gdp} = \frac{\frac{w^e}{\frac{gdp}{pop}} \cdot 100\frac{st}{SAP} \cdot 100\frac{SAP}{pop}}{\frac{st}{tch} \cdot \left(100 - 100\frac{OE}{EE}\right)} = \frac{\frac{w^e}{\frac{gdp}{pop}} \cdot st \cdot \frac{100}{pop}}{\frac{st}{tch} \cdot \left(1 - \frac{OE}{EE}\right)} = \frac{\frac{w^e}{gdp} \cdot 100}{\frac{1}{tch} \cdot \left(1 - \frac{OE}{EE}\right)} = \frac{tch \cdot \frac{w^e}{gdp} \cdot 100}{1 - \frac{OE}{EE}}$$

$$\frac{EE}{gdp} = \frac{tch \cdot \frac{w^e}{gdp}}{1 - \frac{OE}{EE}}$$

$$EE = \frac{tch \cdot w^e}{1 - \frac{OE}{EE}} = \frac{TE}{\frac{TE}{EE}} = EE$$

[6] The school-age population is defined as the population between 2 and 21 years old, given that the average year of entry to primary schools is 6 years old, which is preceded by 4 years of preprimary education.

where EE, TE, and OE refer to education expenditures overall, spending on teachers, and on other areas of education, respectively (in monetary units); tch and st are the number of teachers and students, respectively; and w^e is the annual teacher salary in monetary units.

Then, based on (1) and (19), for each country i in income basket j, we estimate the education spending in 2030 based on the benchmarked parameters, using country-specific projections for economic growth and demographics:

$$Ep_{ij}^{e,T} = f\left(z_j^{e*}, x_{ij}^{e,T}\right) = \frac{wr_j^{e*} \cdot enr_i^* \cdot SAPp_i^T}{STR_j^* \cdot \left(100 - OEsh_j^*\right)} \tag{20}$$

The benchmark values for teachers' wages, wr_j^{e*}, capital and other recurrent spending on education, $OEsh_j^*$, and the student-to-teacher ratio, STR_j^*, are the mean of today's values of the highly performing income peers of country i. The student-age population $SAPp_i^T$ is projected for country i for 2030. We set the benchmark for the enrollment rate in 2030, *enr*, based on a target of universal enrollment for primary and secondary levels and 50 percent for preprimary and tertiary education. This is akin to 2 years each of preprimary and tertiary education and 12 years of combined primary and secondary education. Although this results in a target enrollment rate of about 80 percent, the exact value will be affected by the age distribution of the student-age population. Countries with a higher proportion of the population in the ages corresponding to preprimary and tertiary education will have a lower target enrollment rate than those in which the student-age population is more concentrated in the ages corresponding to primary and secondary education, that is, between the ages of 6 and 17.

Table 4 presents the sources for the data used in costing SDG 4.

Table 4. Variables and Data Sources Used in Costing SDG 4

Variable	Abbreviation	Computation and/or Data Source
SDG4 index		SDG Index and Dashboards, 2022
Enrolment counts (preprimary, tertiary)	st_0, st_3	EdStats, 2022
Enrolment counts (primary, secondary)	st_1, st_2	World Development Indicators, 2022
Teacher counts (preprimary, tertiary)	tch_0, tch_3	EdStats, 2022
Teacher counts (primary and secondary)	tch_1, tch_2	World Development Indicators, 2022
Student-per-teacher ratio	STR	$\frac{\sum_{j=0}^{3} st_j}{\sum_{j=0}^{3} tch_j}$
All staff compensation (% of total public education expenditure)	$staffcomp$	EdStats, 2022
Nonteaching staff compensation (% of total public education expenditure)	$nonteachcomp$	EdStats, 2022
Teaching staff compensation (% of total public education expenditure)	$teachcomp$	$staffcomp - nonteachcomp$
Public expenditure on education (% of GDP)	$pubexp$	World Development Indicators, 2022

Initial public funding of level *k* education, where k = {primary, secondary, tertiary}	$Initialgov_k$	EdStats, 2022
Initial public funding of education (% of GDP per capita), total	$pubfunding$	$\sum_{k=1}^{3} Initialgov_k$
Initial household funding of level k education, where k = {primary, secondary, tertiary}	$Initialhh_k$	EdStats, 2022
Initial household funding of education (% of GDP per capita), total	$privfunding$	$\sum_{k=1}^{3} Initialhh_k$
Private spending on education (% of total education expenditure)	$privshare$	$\frac{privfunding}{pubfunding+privfunding} * 100$
Total spending on education (% of GDP)	Ep^e	$\frac{pubexp}{1-\frac{privshare}{100}}$
Teacher wages (USD)	w^e	$\frac{\frac{pubexp}{100} * \frac{teachcomp}{100} * GDP_{2020}}{\sum_{j=0}^{3} tch_j}$
Teacher wages (USD) adjusted	w_{adj}	$\frac{w^e}{1-\frac{pivshare}{100}}$
Teacher wages (ratio to GDP/capita)	wr^e	$\frac{w_{adj}}{\frac{GDP_{USD,2020}}{Totalpop_{2020}}}$
Other recurrent and capital spending (% total spending)	$OEsh$	$100 - teachcomp$
Student-age population 2020 (number)	$SAPnumber^{2020}$	World Population Prospects, 2022: Sum of population aged 2–21 (2020)
Student-age population 2030 (number)	$SAPnumber^{2030}$	World Population Prospects, 2022: Sum of population aged 2–21 (2030)
Student-age population 2020 (% of total population)	SAP^{2020}	$\frac{SAPnumber^{2020}}{Totalpopulation^{2020}} * 100$
Student-age population 2030 (% of total population)	SAP^{2030}	$\frac{SAPnumber^{2030}}{Totalpopulation^{2030}} * 100$
Enrollment rate (2020)	enr^{2020}	$\frac{\sum_{j=0}^{3} st_j}{SAPnumber^{2020}} * 100$
Population in age group (2–5), 2030	$preprimary_{2030}$	World Population Prospects, 2022
Population in age group (6–11), 2030	$primary_{2030}$	World Population Prospects, 2022
Population in age group (12–17), 2030	$secondary_{2030}$	World Population Prospects, 2022
Population in age group (18–21), 2030	$tertiary_{2030}$	World Population Prospects, 2022
Enrollment rate (2030)	enr^{2030}	$100 * [0.5 * preprimary_{2030} + primary_{2030} + secondary_{2030} + 0.5 * tertiary_{2030}]/SAPnumber^{2030}$

C. Physical Capital Development

C.1. Water and Sanitation (SDG 6)

The water, sanitation, and hygiene (WASH) tool was developed by the World Bank, in collaboration with UNICEF and WHO, with unit costs of WASH facilities calibrated at the country level (Hutton and Varughese 2016). A manual (SWA, n.d.) describes how to use the original World Bank template.[7] The tool estimates the additional cost of providing basic and improved access to water and sanitation. Specifically, two SDG 6 targets are assessed: achieving universal and equitable access to safe and affordable drinking water for all (Target 6.1) and achieving access to adequate and equitable sanitation and hygiene for all and ending open defecation (Target 6.2). The SDG Indicators for Targets 6.1 and 6.2 aspire to “safely managed” WASH services. As a step toward safely managed services, however, the costs of achieving basic—that is, lower-level services—are also estimated, since many countries initially provide basic WASH to their populations. The costs of ending open defecation through simple, traditional, low-cost latrines are also assessed.[8]

Estimates of populations to be served in rural and urban areas by 2030 are based on coverage estimates of WASH services for 2015 (the baseline year), taking into account population growth in rural and urban areas. The total population to be served from 2015 to 2030 is broken down into 15 equal annual tranches to allow estimation of a time series of capital investment as well as operations and maintenance (O&M) needs. The population is disaggregated by wealth quintile, and the model assumes that quintiles with lower coverage in 2015 will be served at a faster rate. There is a choice among technologies in water and sanitation to account for the fact that a mix of lower-cost options can be selected. These options include, for example, community wells for basic water supply, improved latrines for basic sanitation, basins with water and soap for practicing hand-washing, and piped water and sewerage for safely managed water and sanitation. In the baseline estimates, half of the unserved population is assumed to go straight to a higher level of services, while the remaining half pass through basic services before safely managed facilities are accessed.

Hutton and Varughese (2016) and SWA (n.d.) can be consulted for further details on the WASH methodology underlying their tool.

C.2. Electricity (SDG 7)

The SDG7 costing tool calculates the average additional annual spending in 2030 needed to achieve Target SDG 7.1, which states: “By 2030, ensure universal access to affordable, reliable, and modern energy services,” with the first indicator of this target focusing on the proportion of the population with access to electricity. For each country, we estimate the additional electricity network needed to deliver a target level of electricity access to the projected population in 2030, accounting also for an increase in per capita consumption in line with real per-person income growth.

[7] The original user tool can be obtained here.

[8] “Safely managed” for water supply means an on-plot water supply for every household; for sanitation, it includes a toilet with safe management of fecal waste. Basic water supply includes an improved community water source within a 30-minute round trip; basic sanitation includes an improved toilet; and basic hygiene includes a hand-washing station with soap and water for every household.

C.2.a. Expansion of Electricity Coverage and Consumption by 2030

The additional unserved population to be connected in 2030 is:

$$pop_{uns} = pop_T \cdot acc_T - pop_{t0} \cdot acc_{t0} \tag{21}$$

where acc is the share of the current population with electricity coverage (for 2030, the default target level is 1, given the universal coverage goal). The electricity consumption per user today equals the per capita consumption divided by the access rate:

$$elc_{user} = \frac{elc}{user} = \frac{\frac{elc}{pop}}{\frac{user}{pop}} = \frac{elc_{cap}}{acc} \tag{22}$$

where $user$ is the number of people with access to electricity. To derive the corresponding electricity consumption per user in 2030 that is consistent with income growth, we derive the elasticity, β, of electricity consumption with respect to GDP per capita:

$$\ln elc_{cap,i} = \alpha + \beta \ln gdp_{cap,i} + \epsilon_i \tag{23}$$

where elc_{cap} is the per-capita electricity consumption in kilowatt-hours (kWh) and gdp_{cap} is GDP per capita. The regression and its results are shown in Table 5

Table 5. Estimated Coefficients of the Electricity Regression

Variable	$\ln elc_{cap,i}$
$\ln gdp_{cap,i}$	1.060***
	(0.0453)
Constant	–2.072***
	(0.413)
Observations	183
R^2	0.799

Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1

The target consumption per user in 2030 draws on this elasticity:

$$elc_{user}^{T} = elc_{user}^{t0} \cdot \left(1 + \beta \cdot gdp_{cap}^{gr}\right) \tag{24}$$

where

$$gdp_{cap}^{gr} = \frac{gdp_{cap}^{T}}{gdp_{cap}^{t0}} - 1 \tag{25}$$

C.2.b. Additional Cost in 2030 to Meet Electricity Coverage and Consumption Targets

Following this, we estimate the total cost to connect new users ($cost_{nu}$) if they were to maintain the same level of consumption per user as today. To derive this, we multiply the to-be-served population by the consumption per user and the unit cost per kW, UC:[9]

$$cost_{nu,i} = pop_{uns,i} \cdot elc_{user,i}^{t0} \cdot UC \tag{26}$$

A unit cost UC (including generation, transmission, and distribution) per kW of \$2,258 is used, following World Bank (2013).[10]

The next step is to calculate the cost of keeping up with GDP per capita growth—that is, of raising the level of consumption for the whole target population in 2030:[11]

$$cost_{gr} = (pop_{iT} \cdot acc_{iT}) \cdot \left(elc_{user,i}^{T} - elc_{user,i}^{t0}\right) \cdot UC \tag{27}$$

The total cost is given by the sum of the two costs specified previously:

[9] Given that the unit cost is measured in kW and $elc_{user,i}^{t0}$ is in kWh, we convert total consumption to kW by dividing the consumption in kWh by the number of days in the year and hours in the day: $tot\_cons_{nu,i} = \frac{tot\_cons_{nu,i,hr}}{365 \cdot 24}$.

[10] Following the discussion in Fay and Yepes (2003), we assume that 60 percent of the investment cost is for generation, 10 percent for transmission, and 30 percent for distribution.

[11] If GDP per capita growth is negative (and hence the cost would be negative), the analysis sets this cost to zero.

$$cost_{tot,i} = cost_{nu,i} + cost_{gr,i} \quad (28)$$

Finally, the approach outlined in Section C.4 is implemented to obtain the additional annual spending as a percent of GDP required to meet the SDG 7 target of universal access to electricity.

Table 6 provides an overview of the data sources for estimating the additional spending needs for SDG 7.

Table 6. Variables and Data Sources Used in Costing the SDG 7 Target on Electricity

Variable	Abbreviation	Computation and/or Data Source
Electricity access (% of population)	acc_{iT}	World Development Indicators (accessed 2022)
Electricity consumption kWh	elc	World Energy Statistics 2020, IEA-OECD for most countries Projections from the Fossil Fuel Database for remaining countries
Electricity consumption per capita	elc_{cap}	$\frac{elc}{pop}$
Unit cost per kW	*UC*	World Bank (2013)

IEA = International Energy Agency. OECD=Organisation for Economic Co-operation and Development.

C.3. Road Infrastructure (SDG 9)

Analogous to the analysis for SDG 7, the purpose of the roads tool is to calculate the additional spending in 2030 needed to achieve SDG 9's first target 9.1, centered on infrastructure that supports economic development and well-being, with a focus on the first indicator 9.1.1 on roads. Specifically, this indicator measures the proportion of the rural population living within 2 kilometers of an all-season road. Similar to the procedure in the electricity sector, the model takes a two-step approach: First, the road infrastructure gap is estimated, and second, the annual investment needs to close the gap in 2030 are computed given the unit cost to build a road network.

C.3.a. Expanding the Road Network to Improve Access and Meet Economic and Demographic Needs

We quantify how key variables correlate with road network density by regressing the latter on indicators of economic development, demographic structure, and rural access to roads:[12]

$$\ln RD_i = \alpha + \beta_1 \ln gdp_{cap,i} + \beta_2 \ln pdens_i + \beta_3 RAI_i + \beta_4 rur_i + \epsilon_i \quad (29)$$

[12] To smooth the potential impact of outliers, the sample on which the regression is run is restricted to countries whose road density is within two standard deviations of the mean. This approach removed four countries from the sample.

where RD_i is the road density of country i (length of roads in km divided by the area of the country in km^2); gdp_{cap} is the GDP per capita in US dollars; *pdens* is the population density (total population divided by area of the country in km^2); RAI_i is the Rural Access Index, which measures the ratio of the rural population that lives within 2 km of an all-season road (Mikou and others 2019); and rur is the percent of the population that lives in rural areas.

Table 7. Estimated Coefficients from the Roads Regression

Variables	RD_i
RAI_i	0.0105***
	(0.00314)
$\ln gdp_{cap,i}$	0.553***
	(0.0639)
$\ln pdens_i$	0.589***
	(0.0444)
rur_i	0.00719**
	(0.00328)
Constant	–9.500***
	(0.594)
Observations	181
R^2	0.760

Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

The estimated coefficients of the regression are then used to calculate the needed growth rate of road density from today to 2030. β_1 can be interpreted as the roads to GDP per capita elasticity, β_2 as the roads to population density elasticity, β_3 as the percentage increase in road density for an increase of RAI by one unit, and β_4 as the percentage increase in road density for an increase by 1 point in the percent of the population living in rural areas.[13]

We derive from (29) the growth in road length from today to 2030 by expressing the equation for the current period and for 2030, and then subtracting the former from the latter, and simplify, with land area l_{area} being a constant over time:

$$\ln RD_{iT} - \ln RD_{i,t0} = \ln\left(\frac{RD_{iT}}{RD_{i,t0}}\right) = \ln\left(\frac{\frac{RL_{iT}}{l_{area}}}{\frac{RL_{i,t0}}{l_{area}}}\right) = \ln(RL_{iT}) - \ln(RL_{i,to}) \tag{30}$$

[13] To further illustrate this, the resulting regression coefficient on RAI of 0.01045 implies that road density increases by 1.05 percent with an increase in the RAI index by 1 unit (for example, from 57 to 58), and the coefficient on the percent of the rural population of 0.007187 means that road density rises by 0.72 percent with an increase in the percent of the rural population by 1 point (for example, from 62% to 63%).

where RL denotes all-season road length.[14] Conducting the same operation on the right-hand side (RHS) of (29), and simplifying:

$$\begin{aligned}
&\left(\alpha + \beta_1 \cdot \ln gdp_{cap,iT} + \beta_2 \cdot \ln pdens_{iT} + \beta_3 \cdot RAI_{iT} + \beta_4 \cdot rur_{iT} + \epsilon_i\right) \\
&- \left(\alpha + \beta_1 \cdot \ln gdp_{cap,i,t0} + \beta_2 \cdot \ln pdens_{i,t0} + \beta_3 \cdot RAI_{i,t0} + \beta_4 \cdot rur_{i,t0} + \epsilon_i\right) \\
&= \beta_1 \cdot \ln\left(\frac{gdp_{cap,iT}}{gdp_{cap,i,t0}}\right) + \beta_2 \cdot \ln\left(\frac{pdens_{iT}}{pdens_{i,t0}}\right) + \beta_3 \cdot \left(RAI_{iT} - RAI_{i,t0}\right) + \beta_4 \\
&\cdot \left(rur_{iT} - rur_{i,t0}\right) \\
&= \beta_1 \cdot \ln\left(\frac{gdp_{cap,iT}}{gdp_{cap,i,t0}}\right) + \beta_2 \cdot \ln\left(\frac{pop_{iT}}{pop_{i,t0}}\right) + \beta_3 \cdot \left(RAI_{iT} - RAI_{i,t0}\right) + \beta_4 \\
&\cdot \left(rur_{iT} - rur_{i,t0}\right)
\end{aligned} \tag{31}$$

So, bringing (30) and (31) together:

$$\begin{aligned}
&\ln(RL_{iT}) - \ln\left(RL_{i,to}\right) \\
&= \beta_1 \cdot \ln\left(\frac{gdp_{cap,iT}}{gdp_{cap,i,t0}}\right) + \beta_2 \cdot \ln\left(\frac{pop_{iT}}{pop_{i,t0}}\right) + \beta_3 \cdot \left(RAI_{iT} - RAI_{i,t0}\right) + \beta_4 \\
&\cdot \left(rur_{iT} - rur_{i,t0}\right)
\end{aligned} \tag{32}$$

GDP and population data for 2030 are based on projections (see Table 1), while the target RAI value for 2030 is 75 for LIDCs, 90 for EMEs, and 100 for advanced economies (AEs). The target road length for 2030 can now be obtained by solving for it from (32):

$$\begin{aligned}
\ln(RL_{iT}) = {} &\beta_1 \cdot \ln\left(\frac{gdp_{cap,iT}}{gdp_{cap,i,t0}}\right) + \beta_2 \cdot \ln\left(\frac{pop_{iT}}{pop_{i,t0}}\right) + \beta_3 \cdot \left(RAI_{iT} - RAI_{i,t0}\right) + \beta_4 \cdot \left(rur_{iT} - rur_{i,t0}\right) \\
&+ \ln\left(RL_{i,to}\right)
\end{aligned} \tag{33}$$

So:

$$\begin{aligned}
RL_{iT} = \exp\Bigg(&\beta_1 \cdot \ln\left(\frac{gdp_{cap,iT}}{gdp_{cap,i,t0}}\right) + \beta_2 \cdot \ln\left(\frac{pop_{iT}}{pop_{i,t0}}\right) + \beta_3 \cdot \left(RAI_{iT} - RAI_{i,t0}\right) + \beta_4 \\
&\cdot \left(rur_{iT} - rur_{i,t0}\right) + \ln\left(RL_{i,to}\right)\Bigg)
\end{aligned} \tag{34}$$

[14] All-season road length contains both paved and unpaved roads that are in good condition. The latter are calculated by multiplying the total unpaved road length by the normalized mean speed score from Moszoro and Soto (2022).

C.3.b. Additional Cost of the Expanded Road Network

The difference between the target road length and current road length is multiplied by the unit cost, UC, to obtain the cumulative additional cost of construction CC_i:

$$CC_i = \left[\exp\left(\beta_1 \ln\left(\frac{gdp_{cap,iT}}{gdp_{cap,i,t0}}\right) + \beta_2 \ln\left(\frac{pop_{iT}}{pop_{i,t0}}\right) + \beta_3 \left(\frac{RAI_{iT}}{RAI_{i,t0}}\right) + \beta_4 \left(\frac{rur_{iT}}{rur_{i,t0}}\right) + \ln\left(RL_{i,to}\right)\right) - RL_{i,t0}\right] \cdot UC \quad (35)$$

The tool uses a unit cost of 487,168 US$/km, derived from World Bank (2013). The cumulative additional cost of construction amount is then annualized to obtain yearly investment in infrastructure as a constant fraction of GDP (see Section C.4).

Table 8. Variables and Data Sources Used in Costing SDG 9 on Road Infrastructure

Variable	Abbreviation	Computation and/or Data Source
Rural access index	RAI_i	Mikou and others (2019)
Length of roads, LVA	$RL_{i,t0}$	International Road Federation and CIA World Factbook
Unit cost ($/km)	UC	World Bank (2013)

C.4. Additional Annual Cost to Achieve SDG 7 (Electricity) and SDG 9 (Road Infrastructure) Targets

The analysis assesses the additional infrastructure spending to achieve a strong performance in the relevant SDG targets, whereby "additional" means above and beyond (1) the stock of infrastructure that already has been constructed and (2) the cost of maintaining this starting stock. In other words, the "business-as-usual" (BAU) scenario is one in which the country provides, through 2030, upkeep for the infrastructure created but does not expand the network. Thus, to achieve the SDG targets, not only does the network need to be built out, but also the additional infrastructure must be maintained to prevent its depreciation. To account for maintenance costs, we apply a depreciation rate *d* (estimated at 5 percent per year).

C.4.a. The Total Additional Capital Stock Accumulated between Today and the SDG Target Year

Following the standard capital stock accumulation equation, the stock of roads or the electricity infrastructure at any point in time, t, is:

$$K_t = K_{t-1} \cdot (1 - d) + I_t \quad (36)$$

where d is the annual depreciation rate and I_t is the gross investment in year t. Based on this, the capital stock in the year T = 2030 is:

$$K_T = K_{T-1} \cdot (1 - d) + I_T \tag{37}$$

Applying (36) to the capital stock equation for 2029, inserting the RHS of the result into (37), and continuing analogously with years prior to 2029 enables expressing the final-year capital stock as:

$$K_T = K_{t-1} \cdot (1-\delta)^{T+1} + I_t \cdot (1-\delta)^T + \cdots + I_{T-1} \cdot (1-\delta)^1 + I_{T-0} \cdot (1-\delta)^0 \tag{38}$$

So, we have:

$$K_T = K_{t-1} \cdot (1-\delta)^{T+1} + \sum_{s=t}^{T} [I_s \cdot (1-\delta)^{T-s}] \tag{39}$$

where t signifies the current period, the *additional* stock K_{add} accumulated from today to T = 2030 can be expressed by subtracting (36) from (39)—that is,

$$\begin{aligned} K_{add} = K_T - K_t &= K_{t-1} \cdot (1-\delta)^{T+1} + \sum_{s=t}^{T} [I_s \cdot (1-\delta)^{T-s}] - [K_{t-1} \cdot (1-\delta) + I_t] \\ &= K_{t-1} \cdot (1-\delta)[(1-\delta)^T - 1] - I_t + \sum_{s=t}^{T} [I_s \cdot (1-\delta)^{T-s}] \end{aligned} \tag{40}$$

C.4.b. Annual Investment to Create the Total Additional Capital Stock

To have yearly investment in infrastructure be a constant fraction of that year's GDP between today and 2030, investment must grow at the same annual rate as GDP. Thus, we can write investment in the second year as:

$$I_{t+1} = I_t \cdot (1 + g) \tag{41}$$

where g is the annual (constant) growth rate of GDP. And for the following year:

$$I_{t+2} = I_{t+1} \cdot (1 + g) \tag{41}$$

Substituting (41) into (42), and proceeding analogously with successive years' investments, and furthermore letting, for simplicity and without loss of generality, the initial year be $t = 0$, we can write:

$$I_s = I_0 \cdot (1+g)^s \text{ " } s \text{ Î } \{0,\ldots,T\} \tag{42}$$

and specifically, for the end-year $T = 2030$:

$$I_T = I_0 \cdot (1+g)^T \tag{43}$$

Maintaining the current period as $t = 0$ as previously, we can write (40)—that is, the additional stock of infrastructure to be built by 2030 (including replacement of depreciated infrastructure)—as:

$$\begin{aligned} K_{add} &= K_{-1} \cdot (1-\delta)[(1-\delta)^T - 1] - I_0 + \sum_{s=0}^{T} [I_s \cdot (1-\delta)^{T-s}] \\ &= K_{-1} \cdot (1-\delta)[(1-\delta)^T - 1] - I_0 + (1-\delta)^T \sum_{s=0}^{T} \frac{I_s}{(1-\delta)^s} \end{aligned} \tag{44}$$

Inserting (43) into (45):

$$\begin{aligned} K_{add} &= K_{-1} \cdot (1-\delta)[(1-\delta)^T - 1] - I_0 + (1-\delta)^T \cdot \sum_{s=0}^{T} \frac{I_0 \cdot (1+g)^s}{(1-\delta)^s} \\ &= K_{-1} \cdot (1-\delta)[(1-\delta)^T - 1] - I_0 + (1-\delta)^T \cdot I_0 \cdot \sum_{s=0}^{T} a^s \end{aligned} \tag{45}$$

where

$$a = \frac{1+g}{1-\delta} \tag{46}$$

As the last summation term in (46) is a geometric series,[15] the whole expression becomes:

$$K_{add} = K_{-1} \cdot (1-\delta)[(1-\delta)^T - 1] + I_0 \cdot \left[(1-\delta)^T \cdot \frac{1-a^{T+1}}{1-a} - 1\right] \tag{48}$$

Solving (36) for capital stock in year t-1, and applying that to the current year $t = 0$:

$$K_{-1} = \frac{K_0 - I_0}{1-\delta} \tag{47}$$

Inserting this into (48) gives:

$$\begin{aligned} K_{add} &= \frac{K_0 - I_0}{1-\delta}(1-\delta)[(1-\delta)^T - 1] + I_0 \cdot \left[(1-\delta)^T \cdot \frac{1-a^{T+1}}{1-a} - 1\right] \\ &= K_0 \cdot [(1-\delta)^T - 1] - I_0 \cdot [(1-\delta)^T - 1] + I_0 \cdot \left[(1-\delta)^T \frac{1-a^{T+1}}{1-a} - 1\right] \\ &= K_0 \cdot [(1-\delta)^T - 1] + I_0 \cdot \left[(1-\delta)^T \frac{1-a^{T+1}}{1-a} - 1 - (1-\delta)^T + 1\right] \\ &= K_0 \cdot [(1-\delta)^T - 1] + I_0 \cdot \left[(1-\delta)^T \left(\frac{1-a^{T+1}}{1-a} - 1\right)\right] \end{aligned} \tag{50}$$

From this we can solve for today's investment:

$$K_{add} - K_0 \cdot [(1-\delta)^T - 1] = I_0 \cdot \left[(1-\delta)^T \left(\frac{1-a^{T+1}}{1-a} - 1\right)\right] \tag{48}$$

$$I_0 = \frac{K_{add} - K_0 \cdot [(1-\delta)^T - 1]}{(1-\delta)^T \left(\frac{1-a^{T+1}}{1-a} - 1\right)} \tag{49}$$

All elements on the right side are known or estimated. Thus, we can derive a value for initial investment I_0. Dividing this investment by today's GDP (that is, GDP_0) yields the investment needed as a percent of GDP:

[15] According to the geometric series rule, $\sum_{n=0}^{N} x^n = \frac{1-x^{N+1}}{1-x}$.

$$100\frac{I_0}{gdp_0} = 100\frac{K_{add} - K_0 \cdot [(1-\delta)^T - 1]}{gdp_0 \cdot (1-\delta)^T \left(\frac{1-a^{T+1}}{1-a} - 1\right)}$$

Given that the previous derivations ensure that the ratio of investment-to-GDP is constant across years, it holds that:

$$I_{con}^{pg} = 100\frac{I_0}{gdp_0} = 100\frac{I_t}{gdp_t} \; \forall\, t \in \{t_0, \ldots, T\} \quad (50)$$

where the subscript con denotes that the amount as a percent of GDP (superscript pg) is constant every year.

C.4.c. Netting Out the Cost of Maintaining the Current Infrastructure Stock through 2030

As mentioned earlier, the intention is to estimate the additional annual investment to achieve the SDG targets of the infrastructure sector, as investments that are above and beyond the BAU case in which the country builds the infrastructure observed in the current/initial year (that is, 2020) and continues to maintain only this stock into the future. The investment in (52), however, still includes the maintenance cost into the future of the initial infrastructure accumulated by the current period. Thus, we need to net out, from the amount in (52), this future depreciation cost of the current stock. For this, we first derive the future maintenance cost of current infrastructure.

In the first future year (that is, $t = 1$) this maintenance cost, DEP, amounts to the current stock times the depreciation rate:

$$DEP_1^b = K_0 \cdot \delta \quad (51)$$

where b denotes BAU. In the second year, because in the BAU scenario (1) the infrastructure network is not being extended and (2) the initial stock received maintenance services in the first year, the depreciation cost remains the same:

$$DEP_2^b = K_0 \cdot \delta \quad (52)$$

Generally, each year the depreciation cost is constant. Aggregating to calculate the cumulative maintenance cost:

$$DEP^{b}_{cum} = \sum_{t=1}^{T} DEP^{b}_{t} = T \cdot K_0 \cdot \delta \tag{53}$$

where the superscript cum serves as a reminder that this is a cross-year cumulative quantity. Before subtracting BAU maintenance from (52), we need to (1) annualize the cumulative BAU cost and (2) do so in a way that the resultant T annual amounts are constant as a share of GDP. Following the same logic as expressed in (41) and thereafter, the depreciation cost (in monetary units, not yet as a share of GDP) of the second year must grow from that of the first year at the same rate as GDP growth:

$$DEP^{b}_{2,con} = DEP^{b}_{1,con} \cdot (1 + g) \tag{54}$$

where con indicates that the depreciation cost to be derived is constant as a share of GDP. More generally, and given that:

$$DEP^{b}_{1,con} = DEP^{b}_{1,con} \cdot (1 + g)^{0} \tag{55}$$

we can write:

$$DEP^{b}_{t,con} = DEP^{b}_{1,con} \cdot (1 + g)^{t-1} \; \forall \; t \in \{t_0+1,\ldots,T\} \tag{56}$$

or:

$$DEP^{b}_{t+1,con} = DEP^{b}_{1,con} \cdot (1 + g)^{t} \; \forall \; t \in \{t_0,\ldots, T-1\} \tag{57}$$

As these annual amounts need to add up to the cumulative total, using the (60) and (56):

$$\sum_{t=0}^{T-1} DEP_{t+1,con}^{b} = T\,K_0 \cdot \delta \tag{58}$$

Using (60) and the geometric series formula, the left side of (61) can be written as:

$$\sum_{t=0}^{T-1} DEP_{t+1,con}^{b} = \sum_{t=0}^{T-1} \left[DEP_{1,con}^{b} \cdot (1+g)^{t}\right] = DEP_{1,con}^{b} \frac{1-(1+g)^{T}}{1-(1+g)} = DEP_{1,con}^{b} \frac{(1+g)^{T}-1}{g} \tag{59}$$

Inserting this into the left side of (61), then solving for the first year's BAU depreciation cost, which is by construction constant as a share of GDP:

$$DEP_{1,con}^{b} = \frac{T \cdot\ K_0 \cdot \delta \cdot g}{(1+g)^{T}-1} \tag{60}$$

Note that the denominator is always positive (if GDP growth g is positive). Based on (59), we are now ready to derive the BAU depreciation cost in the year 2030:

$$DEP_{con,T}^{b} = DEP_{1,con}^{b}(1+g)^{T-1} \tag{61}$$

Substituting (63) into (64):

$$DEP_{con,T}^{b} = \frac{T\,K_0 \cdot \delta \cdot g \cdot (1+g)^{T-1}}{(1+g)^{T}-1} \tag{62}$$

To arrive at the constant-across-years BAU depreciation cost as a percent of GDP (subscript pg), we divide (65) by 2030 GDP:

$$DEP_{con,T}^{b,pg} = 100 \frac{T\,K_0 \cdot \delta \cdot g \cdot (1+g)^{T-1}}{gdp_T \cdot [(1+g)^{T}-1]} \tag{63}$$

As the last step, to arrive at the annual investment (as a share of GDP) needed to achieve a strong SDG performance for the infrastructure sector, (66) is subtracted from (53):

$$INV_{con}^{SDG} = I_{con}^{pg} - DEP_{con,T}^{b,pg} = 100\left\{\frac{K_{add} - K_0 \cdot [(1-\delta)^T - 1]}{gdp_0 \cdot (1-\delta)^T \left(\frac{1-a^{T+1}}{1-a} - 1\right)} - \frac{T\, K_0 \cdot \delta \cdot g \cdot (1+g)^{T-1}}{gdp_T \cdot [(1+g)^T - 1]}\right\} \qquad (64)$$

D. Aggregation of Additional SDG Costs across SDG Areas and Countries

This section provides an overview on how the additional SDG spending needs are aggregated across sectors and countries.

The total (that is, for all five SDG areas combined) additional spending needs TS_i in 2030 for each country i expressed in percent of 2030 GDP is the sum of all five sectors' additional spending S_{ij}:

$$TS_i = \sum_{j=1}^{5} S_{ij}$$

In this process, a missing additional cost for any of the four sectors besides water and sanitation results in TS_i set to missing. A missing WASH additional cost for AE countries is treated as zero, as the World Bank's model systematically did not compute unit costs for AEs and other data sources (for example, the World Development Indicators) show that all AEs have achieved or nearly achieved universal access to water and sanitation. We apply the equation irrespective of the sign of S_{ij};—that is, also when $S_{ij} < 0$— as is the case for a few countries i and sectors j. Negative additional spending on a single sector for a country may result in the social sectors if the country can achieve a good SDG performance with fewer resources—in most such cases, there would still be a need to tackle spending inefficiencies in that particular sector (as discussed earlier). Negative S_{ij} may also obtain SDG 7 if GDP per capita or population are projected to decline and the country already has or is close to having universal access to electricity today. In this case, electricity consumption needed to reach the goal will be lower than current consumption.

Given that the goal of this methodology is to quantify additional spending needs to reach selected SDGs, if $TS_i <$ 0, then total additional spending for country i is set to zero. The cross-sector average across countries TS (for example, for an income group or region) is obtained by weighing the country estimates TS_i using their real 2030 GDP (in 2020 prices).

We next describe the process to obtain sector-specific averages across countries—that is, S_j—for example, the average additional health spending for sub-Saharan Africa (SSA), additional education spending for SSA, and so on. Prior to obtaining S_j, the underlying S_{ij} are adjusted as follows: (1) For a country i for which TS_i was originally negative and was thus set to zero (as previously described), S_{ij} is set to zero for each *j* of this country; (2) if S_{ij} is missing for any *j* of this country, S_{ij} is set to missing for all sectors j of the country; and (3) as before, S_{ij} = 0 for AE countries' WASH sector. After these adjustments, S_j is derived as the real 2030 GDP-weighted average of S_{ij} for the group of countries *i* in question.

Where available, the total and sectoral additional spending desk estimates are replaced in the tool by estimates from in-depth country studies (for example, resulting from IMF capacity development missions or analytical work during surveillance missions).

E. Summary Results of the Third Edition SDG Costing Tool

This final section presents key results on the additional spending needs to achieve a strong performance in selected SDGs, based on the third edition of the IMF SDG Costing Tool, with some comparison with and changes from the initial spending needs assessment of Gaspar and others (2019). The Appendix presents the latest (third edition) desk estimates for countries and sectors for which there are positive additional spending needs to achieve outcomes in line with well-performing peers and selected SDG targets. This discussion also highlights that desk estimates are robust at the country group level, while in-depth country-level assessments are needed for sound and reliable results at the country level. The results based on such in-depth analyses are highlighted bold and in blue in the Appendix.

The significant differences in SDG outcomes between income groups observed a few years ago during the first edition costing analysis remain; however, there have been improvements in outcomes over time. AEs perform, on average, distinctly better in the SDGs than do EMEs, which in turn are well ahead of LIDCs (Figure 1).[16] LIDCs also strongly lag AEs and EMEs in the selected sectoral outcomes in human and physical capital development. There is, furthermore, a wide distribution in performance within income groups, especially among LIDCs. That said, over the last four years since 2018 (see Gaspar and others 2019), all income groups saw some improvement, the largest of which materialized for EMEs. These improvements, while moderate, are not insubstantial: For example, the median performance of EMEs and AEs rose by an amount similar in size to the gap in 2018 between the median and the 75th percentile among EMEs and AEs, respectively. However, improvements had primarily materialized prior to the pandemic, with the health crisis leading to a partial backsliding (Sachs and others 2022).

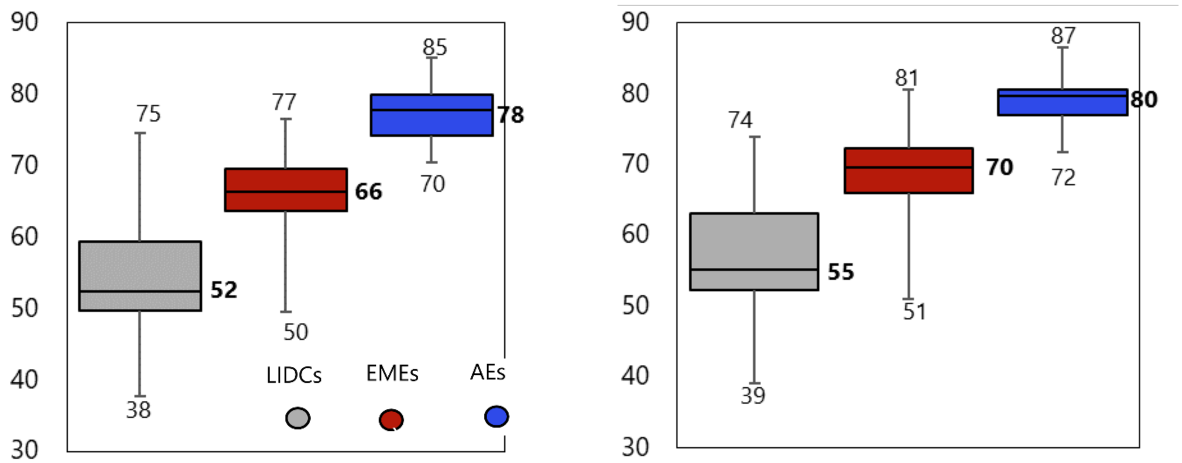
[16] These performance statistics are based on a composite SDG index score from 2022 that reflects performance across all 17 SDGs, ranging from 0 to 100, reflecting the lowest- and highest-possible performance levels. These latest statistics show a gap of 10 points between the median value of EMEs and that of AEs—and an even larger gap of 15 points between the median LIDC and EME. It should be noted that even the highest-performing country remains relatively far from the maximum achievable score of 100.

Figure 1. Overall Performance of the 17 SDGs

(SDG index; 0 and 100 = lowest and highest possible performance, respectively)

1. Performance in 2018 (Gaspar and others 2019)

2. Current Performance (2022)



Source: Gaspar and others (2019).

Source: IMF SDG Performance Tool, based on Sachs and others (2022).

Note: AEs = advanced economies; EMEs = emerging market economies; LIDCs = low-income developing countries. Horizontal lines inside the boxes are the median SDG index values. The top and bottom parts of the boxes are the upper and lower quartiles. The top and bottom horizontal lines of the "whiskers" are the minimum and maximum values.

The disparities in SDG outcomes across income groups are also mirrored in additional spending needs to close the performance gap. Globally, additional spending required to achieve a strong performance[17] in the selected SDGs in 2030 amounts to $3 trillion (3.4 percent of 2030 world GDP).[18] Estimated at 16.1 percent of 2030 LIDC GDP, the average additional SDG cost of this income group is significantly higher than in EMEs, which face additional spending amounting to 4.8 percentage points of their GDP in 2030 (Figure 2, panel 1). These updated results constitute a moderate rise in added spending needs for EMEs and LIDCs, compared with the previous prepandemic estimates. In contrast to EMEs and LIDCs, the additional cost for AEs is less than 0.2 percent of their 2030 GDP. Considering the geographic distribution, additional SDG costs also rose for each region. SSA continues to have, by far, the largest additional expenditure burden—at 19.4 percentage points of GDP—to achieve a good performance in the SDGs. This is followed by the Caucasus and Central Asia, the average additional spending requirement of which is estimated at 11.7 percentage points of GDP. Besides AEs, the region with the lowest additional spending needs is Latin America and the Caribbean (LAC; 2.5 percentage points of GDP).

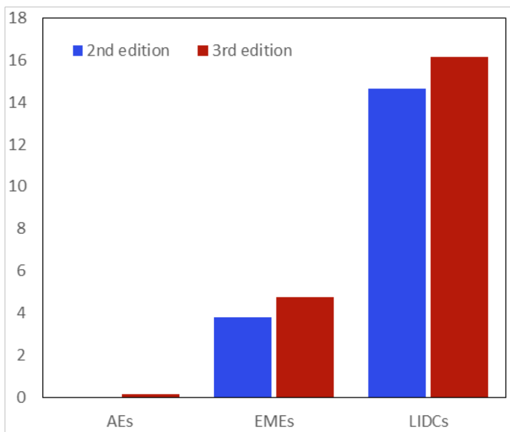
[17] In the SDG costing methodology, the target performance in 2030 for a given country is determined by a combination of absolute targets, derived from SDG targets indicators, and the use of values from income peers with the highest SDG outcomes. For example, in education, the student-to-teacher ratio to be achieved in 2030 by a country is the average student-to-teacher ratio of high-SDG4 countries among the income-peers, while the target gross enrollment rate (preprimary to tertiary levels in aggregate) is 80 percent for all countries, based on SDG4 targets.

[18] All cross-country averages of additional spending needs presented in this note are weighted by 2030 GDP, following Gaspar and others (2019).

Figure 2. Average Additional Spending Needs in 2030

(Percentage points of GDP)

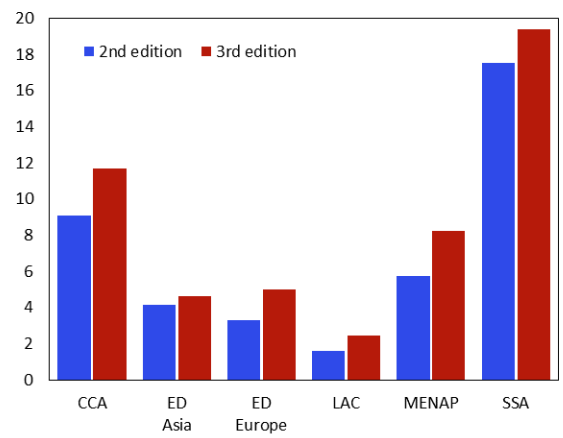
1. By Income Group



Source: Staff calculations, based on IMF SDG Costing Tool, second and third editions.

Note: AEs = advanced economies; EMEs = emerging market economies; LIDCs = low-income developing countries.

2. By Region



Source: Staff calculations, based on IMF SDG Costing Tool, second and third editions.

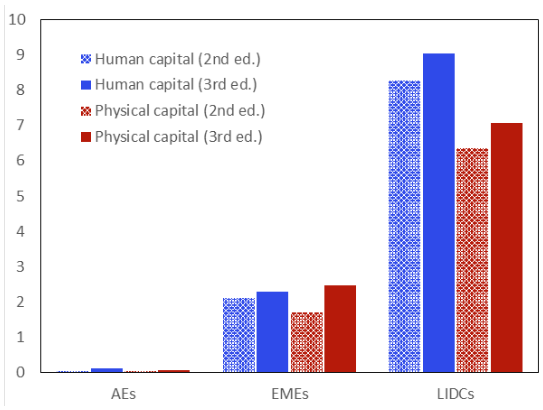
Note: CCA = Caucasus and Central Asia; ED = Emerging and Developing; LAC = Latin America and the Caribbean; MENAP = Middle East, North Africa, Afghanistan, and Pakistan; SSA = sub-Saharan Africa.

The amounts the world will need to spend additionally to meet human versus physical capital development needs are about equal—1.70 and 1.71 percentage points of GDP, respectively. However, the balance differs by country group. The new estimates point not only to higher additional spending needs in the aggregate but also when considering resources for human capital and infrastructure separately (Figure 3, panel 1). Between these two sectoral areas, LIDCs will need to expend relatively more on human capital development, while EMEs' additional costs are somewhat higher in the infrastructure sectors. The Middle East, North Africa, Afghanistan, and Pakistan region faces additional costs in meeting the SDGs for human development that are more than double those for infrastructure (Figure 3, panel 2). The reverse is the case for countries in LAC and in emerging and developing Europe, which will need to concentrate the balance of its efforts on expanding infrastructure.

Figure 3. Average Additional Cost for Human and Physical Capital Development in 2030

(Percentage points of GDP)

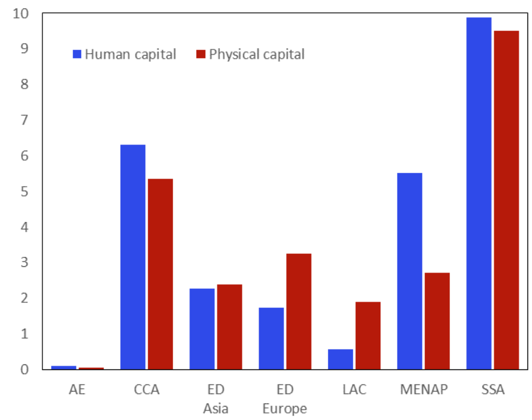
1. By Income Group



Source: Staff calculations, based on IMF SDG Costing Tool, second and third editions.

Note: AEs = advanced economies; EMEs = emerging market economies; LIDCs = low-income developing countries.

2. By Region



Source: Staff calculations, based on IMF SDG Costing Tool, third edition.

Note: Note: AE = advanced economy; CCA = Caucasus and Central Asia; ED = Emerging and Developing; LAC = Latin America and the Caribbean; MENAP = Middle East, North Africa, Afghanistan, and Pakistan; SSA = sub-Saharan Africa.

Appendix

The Appendix table presents the latest (third edition) desk estimates for countries' additional spending needs to achieve outcomes in line with well-performing peers and selected SDG targets. The total (that is, for all five SDG areas combined) additional spending needs in 2030 for each country expressed in percent of 2030 GDP is the sum of all five sectors' additional spending. This summing applies also when the additional sectoral needs are negative (see discussion in Section D for further details).[19] Appendix Table A1 reports the positive additional costs. Desk estimates are robust at the country group level, while in-depth country-level assessments are needed for sound and reliable results at the country level. Country-level desk estimates should not be used for drawing policy conclusions for the country in question. Results already published that are based on such in-depth analyses are highlighted bold and in blue.

Table A 1. Country-Level Desk Estimates of Additional SDG Spending Needs

Country	Health	Education	WASH	Electricity	Roads	Total
Albania	3.94		0.16	0.48	1.99	3.74
Algeria	3.71	3.06	0.78	0.28	1.05	8.88
Angola	**5.70**	**8.30**	**2.10**	**1.20**	**3.50**	**20.80**
Antigua and Barbuda	5.16		0.43	0.20	3.35	8.55
Argentina			0.21	0.32	3.05	2.28
Armenia		2.01	0.20	0.62	4.49	6.49
Aruba			0.43	0.22	1.60	
Australia				0.14	2.19	
Austria				0.11	0.35	
Azerbaijan	6.80	2.38	0.39	0.40	2.66	12.62
Bahamas	3.64	0.55	0.43	0.11	1.13	5.86
Bahrain	5.18	1.01	0.62	0.89	0.46	8.18
Bangladesh	7.45	4.15	0.51	0.54	2.09	14.74
Barbados	2.63		0.43	0.15	1.80	2.90
Belarus	4.47		0.21	0.03	7.98	10.78
Belgium				0.09	0.29	
Belize	4.40		1.19	0.27	9.15	10.82
Benin	**5.10**	**3.20**	**2.50**	**2.40**	**8.10**	**21.30**
Bhutan	6.27		0.64	1.53	11.02	1.75
Bolivia	1.91		0.36	0.28	9.15	
Bosnia and Herzegovina			0.13	0.56	1.45	
Botswana	2.66		0.50	0.65	11.79	13.16
Brazil			**0.30**	**0.10**	**3.00**	
Brunei Darussalam	7.29		0.27	0.23	1.03	6.54
Bulgaria	1.72		0.04	0.47	1.41	1.69
Burkina Faso	3.78	6.47	1.88	2.52	3.62	18.27
Burundi	1.17	7.58	5.18	2.63	3.55	20.10
Cabo Verde	5.31		0.71	0.29	2.62	8.91
Cambodia	**3.10**	**1.50**	**0.40**	**1.20**	**1.20**	**7.40**
Cameroon	5.44	6.93	1.41	0.57	4.63	18.99
Canada				0.23	2.28	
Central African Republic	1.48	12.09	2.50	1.30	29.63	47.00
Chad	**6.00**	**9.70**	6.41	0.58	15.05	37.75
Chile			0.43	0.28	1.34	
China	3.82		0.09	0.71	1.07	3.71
Colombia	1.63		0.29	0.34	2.96	3.30
Comoros	3.01	8.21	1.92	0.09	3.28	16.52
Congo, Democratic Republic of	5.80	10.50	6.80	5.90	14.90	43.90
Congo, Republic of	7.50	7.05	2.20	0.70	8.69	26.14
Costa Rica	1.78		0.47	0.19	1.88	
Côte d'Ivoire	5.83	8.08	1.36	0.43	5.53	21.23
Croatia	1.71		0.14	0.34	0.41	0.89
Cyprus	2.02			0.19	0.67	
Czech Republic	0.88			0.22	0.44	0.41

[19] For example, in a country case for which four sectoral costs are displayed (because the fifth estimate is negative), the cross-sector total for a country may be lower than the sum of four shown positive estimates.

Country	Health	Education	WASH	Electricity	Roads	Total
Denmark				0.06	0.56	
Djibouti	8.26	0.96	1.16	0.53	3.64	14.56
Dominica	3.22		0.37	0.10	8.23	9.39
Dominican Republic	2.93	0.19	0.59	0.41	0.66	4.77
Ecuador	2.44	0.50	0.34	0.25	1.12	4.66
Egypt	5.37	3.23	0.36	0.73	0.36	10.05
El Salvador	2.96		0.99	0.24	1.14	3.50
Equatorial Guinea	6.39	9.26	1.35	0.07	0.60	17.68
Eritrea	4.80	9.19	11.25	0.87	6.26	32.36
Estonia	1.92			0.26	6.34	6.62
Eswatini	2.21	4.40	0.95	0.41	2.33	10.31
Ethiopia	5.98	6.44	2.88	0.67	4.99	20.96
Fiji	6.32		0.29	0.15	2.74	8.53
Finland				0.15	0.88	
France				0.11	0.57	
Gabon	5.77	3.68	0.96	0.20	2.65	13.26
Gambia	5.54	8.25	1.57	0.62	3.61	19.59
Georgia	2.20	0.34	0.17	1.32	6.75	10.78
Germany				0.07	0.14	
Ghana	6.18	5.84	1.34	0.60	2.09	16.05
Greece	1.16			0.21	0.75	0.23
Grenada	3.77	0.33	0.20	0.19	1.53	6.02
Guatemala	**1.40**	**3.30**	**0.60**	**0.20**	**3.20**	**8.70**
Guinea	5.28	5.74	1.63	1.45	7.39	21.49
Guinea-Bissau	0.97	8.19	2.74	0.24	11.02	23.15
Guyana	3.83	0.07	0.09	0.61	3.00	7.59
Haiti	4.76	7.69	1.64	0.12	0.22	14.44
Honduras	2.40	1.35	1.30	0.53	1.86	7.43
Hong Kong				0.13		
Hungary	2.13		0.14	0.29	1.52	1.81
Iceland	0.19			0.70	0.44	
India	**3.80**		**0.20**	**1.00**	**2.70**	**6.20**
Indonesia	**2.80**		**0.50**	**1.40**	**0.90**	**4.20**
Iran	2.34	0.66	0.23	0.21	1.57	5.00
Iraq	5.82	4.50	0.99	0.32	1.75	13.37
Ireland	2.07	0.13		0.10	0.59	2.89
Israel	0.94			0.19	0.12	
Italy	0.36			0.08	0.28	
Jamaica	4.59		0.74	0.17	5.12	8.14
Japan				0.06	0.16	
Jordan	2.85	3.86	0.36	0.42	0.68	8.17
Kazakhstan	5.92	2.69	0.21	0.46	3.49	12.76
Kenya	4.55	4.39	0.98	0.30	3.31	13.53
Kiribati			0.42	0.13	7.02	
Korea, South	1.38			0.27	0.08	
Kuwait	4.30		0.62	0.56		2.00
Kyrgyzstan	4.94	2.07	0.56	1.89	16.60	26.05

Country	Health	Education	WASH	Electricity	Roads	Total
Lao	7.05	0.24	0.55	0.42	7.82	16.07
Latvia	2.05			0.20	3.37	4.22
Lesotho		0.47	4.63	0.85	8.56	12.44
Liberia	0.76	9.29	3.92	1.26	8.50	23.73
Libya	2.97	3.07	0.42	5.96	14.40	26.81
Lithuania	1.90			0.17	1.64	3.00
Luxembourg	3.54			0.08	0.14	2.97
Macao				0.12		
Macedonia, North	1.82		0.13	0.57	1.16	3.06
Madagascar	5.58	7.97	4.83	1.61	9.71	29.70
Malawi	1.43	9.86	1.55	2.61	4.17	19.61
Malaysia	5.15		0.25	0.64	2.70	7.04
Maldives	0.06		0.14	0.08	0.24	
Mali	5.46	9.39	2.38	0.93	25.07	43.23
Malta	0.49			0.22	0.45	
Marshall Islands			0.37		22.00	
Mauritania	5.30	7.10	2.30	0.70	3.80	19.20
Mauritius	3.10		0.38	0.31	0.40	1.70
Mexico	**0.50**	**0.50**	0.27	0.20	2.58	4.04
Micronesia			0.32	0.13	1.60	
Moldova	3.19		0.12	0.72	2.30	1.07
Mongolia	6.42		0.37	0.81	37.18	44.75
Montenegro	0.58		0.10	0.83	4.35	
Morocco	5.12	0.10	0.94	0.33	2.81	9.30
Mozambique	1.10	4.35	3.18	11.84	11.18	31.66
Myanmar	**5.50**	**4.80**	**0.60**	**1.00**	**1.30**	**13.20**
Namibia	0.80		1.80	2.60	3.30	6.50
Nauru		1.53	0.13	0.16		0.37
Nepal	4.84		0.76	0.39	1.49	2.30
Netherlands				0.08	0.22	
New Zealand				0.15	0.72	
Nicaragua	1.07	3.81	1.85	0.47	4.38	11.58
Niger	3.24	9.58	2.75	1.80	6.68	24.07
Nigeria	**4.20**	**7.70**	**3.10**	**1.00**	**2.00**	**18.00**
Norway				0.21	0.17	
Oman	4.56	0.15	0.62	0.43	3.33	9.09
Pakistan	**5.40**	**5.70**	**2.00**	**0.70**	**2.30**	**16.10**
Palau			0.25		1.79	
Panama	0.74	1.16	0.15	0.37	1.78	4.21
Papua New Guinea	7.03	4.82	0.45	0.76	1.69	14.75
Paraguay	3.04	2.29	0.31	0.38	9.29	15.31
Peru	3.44		0.18	0.31	0.58	2.16
Philippines	5.75	2.15	0.33	0.50	1.24	9.97
Poland	2.19		0.14	0.26	2.00	2.89
Portugal				0.17	0.56	
Puerto Rico				0.01	0.37	
Qatar	5.97		0.62	0.29	0.16	6.74

Country	Health	Education	WASH	Electricity	Roads	Total
Romania	2.90		0.11	0.21	0.42	3.09
Russia	3.17		0.22		5.90	7.33
Rwanda	**2.00**	**7.10**	**4.50**	**2.00**	**3.90**	**19.50**
Saint Kitts and Nevis	3.48	0.63	0.43	0.12	0.24	4.90
Saint Lucia	4.88		0.32	0.16	2.99	7.39
Saint Vincent and the Grenadines	4.06		0.38	0.10	4.65	6.19
Samoa	3.36	4.90	0.22	0.08	7.99	16.57
San Marino	2.95				0.39	
Sao Tome and Principe	3.43	5.83	1.25	0.32	4.71	15.54
Saudi Arabia	3.70		0.62	0.44	1.23	5.37
Senegal	5.09	5.16	1.47	0.61	2.82	15.15
Serbia			0.09	0.72	2.05	1.61
Seychelles	1.43		0.32	0.35	0.96	2.90
Sierra Leone	0.11		5.86	0.49	8.53	13.50
Singapore	5.48			0.15		5.33
Slovakia	1.65			0.25	1.81	2.65
Slovenia	0.30			0.28	2.01	0.62
Solomon Islands	4.52		0.34	0.08	2.70	
Somalia		12.27	2.20	0.21	6.60	
South Africa	1.07		0.44	0.68	12.27	12.42
South Sudan	3.22	10.95	2.85	4.13	46.46	67.62
Spain				0.16	1.42	
Sri Lanka	6.34	2.22	0.41	0.17	1.70	10.85
Sudan	4.73	9.11	5.24	1.83	4.55	25.47
Suriname	0.82		0.68	0.45	5.21	3.84
Sweden				0.18	3.54	
Switzerland				0.04	0.10	
Taiwan				0.34	0.12	
Tajikistan	2.60	1.95	0.98	2.50	15.77	23.79
Tanzania	5.55	8.97	2.47	0.81	5.84	23.63
Thailand	5.70		0.26	0.39	1.12	6.15
Timor-Leste	2.30		2.04	0.20	5.47	
Togo	3.48	5.26	1.39	0.95	4.09	15.17
Tonga	5.16		0.33	0.05	4.55	5.96
Trinidad and Tobago	2.05		0.43	0.22	1.59	3.54
Turkey	4.69		0.25	0.43	0.52	5.39
Turkmenistan	**0.80**	**3.60**	**0.20**	0.16	**3.80**	8.56
Tuvalu		2.09	0.09		0.61	
Uganda	5.50	9.46	1.74	0.66	1.29	18.66
United Arab Emirates	4.55		0.62	0.43	0.05	5.41
United Kingdom				0.08	0.26	
United States				0.14	0.59	
Uruguay			0.43	0.19	6.86	4.64
Uzbekistan	**2.30**	**0.30**	**1.00**	**0.80**	**4.30**	**8.70**
Vanuatu	6.07	8.85	0.30	0.14	3.54	18.90
Vietnam	**0.80**		**0.50**	**2.80**	**2.90**	**6.00**
Yemen	4.96	3.63	1.66	0.32	9.40	19.97
Zambia	4.27	6.66	5.60	4.20	17.46	38.19
Zimbabwe	1.39	7.51	1.71	1.37	20.66	32.64

Source: Authors' estimates.

Note: WASH = Water, Sanitation and Hygiene.

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