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The Spending Challenge of Achieving the SDGs
in South Asia: Lessons from India

by Mercedes García-Escribano, Tewodaj Mogues,
Mariano Moszoro, and Mauricio Soto

I N T E R N A T I O N A L M O N E T A R Y F U N D

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Fiscal Affairs Department

The Spending Challenge of Achieving the SDGs in South Asia: Lessons from India¹**Prepared by Mercedes García-Escribano, Tewodaj Mogues,
Mariano Moszoro, and Mauricio Soto**

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Abstract

South Asia has experienced significant progress in improving human and physical capital over the past few decades. Within the region, India has become a global economic powerhouse with enormous development potential ahead. To foster human and economic development, India has shown a strong commitment to the Sustainable Development Goals (SDG) Agenda. This paper focuses on the medium-term development challenges that South Asia, and in particular India, faces to ensure substantial progress along the SDGs by 2030. We estimate the additional spending needed in critical areas of human capital (health and education) and physical capital (water and sanitation, electricity, and roads). We document progress on these five sectors for India relative to other South Asian countries and discuss implications for policy and reform.

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I. INTRODUCTION

South Asia has experienced significant progress in improving human development over the past few decades. With sustained income growth and strong policy efforts, the region, which accounts for one-fifth of the world's population, has contributed to over 200 million people exiting poverty in the course of the last three decades (Goretti et al., 2019). Nonetheless, some South Asian countries' human capital index is lower than what their GDP per capita would predict. And South Asia, on average, still lags East Asia and the Pacific as well as Latin America and the Caribbean in access to key infrastructure such as electricity, water, sanitation, and telecommunication (Jha and Arao, 2018).

Within the region, India has become a global economic powerhouse with enormous development potential ahead. Unlocking this potential requires investments in human and physical capital. In this regard, India has made astonishing progress along several dimensions. Hundreds of millions have lifted themselves out of poverty over the past decades. Education enrollment is now nearly universal for primary school. Infant mortality rates have been halved since 2000. Access to water and sanitation, electricity, and roads has greatly improved. Nonetheless, to further capitalize on economic growth, India should continue to close gaps in human and physical capital—gaps that have recently widened as a result of the pandemic. Indeed, after years of steady progress, during the COVID-19 pandemic health and education systems have been disrupted, poverty has increased, and the prevalence of undernourishment has risen (UN, 2021 and FAO, 2021). However, South Asia is projected to have the strongest improvement in poverty reduction of any region in 2021, with only a minor deterioration relative to pre-pandemic projections (Mahler et al., 2021).

To foster human and economic development, India has shown a strong commitment to the Sustainable Development Goals (SDG) Agenda. The government has aligned its development priorities with the SDG framework. India recently underwent two Voluntary National Reviews (Government of India, NITI Aayog, 2017 and 2020), and carried out a third round of stocktaking of progress in meeting the SDGs (Government of India, NITI Aayog, 2021) providing SDG metrics, including at the state level. Numerous national flagship programs that seek to connect villages to roads, launch initiatives to provide universal health coverage and sanitation, and aim at other ambitious development objectives are intimately linked to the SDGs. States and union territories are taking proactive steps to implement the goals, underpinned by national and regional consultations, although more can be done to reduce wide subnational disparities (Government of India, NITI Aayog, 2021).²

This paper focuses on the medium-term development challenges that South Asia, and in particular India, faces, namely, the additional spending—public and private—needed to ensure substantial progress along the SDGs by 2030. The focus of the paper is on critical areas of human capital (health and education) and physical capital (water and sanitation, electricity, and roads),

² For example, based on government calculations, states and Union territories range in their SDG index from 52 to 75.

following the methodology developed by Gaspar et al. (2019).³ We find that an additional 6.2 percent of GDP per year will have to be spent in India in these five areas to achieve a high SDG performance in 2030, and preliminary desk estimates for the other South Asian countries combined point to an additional spending need of 11.3 percent of GDP in the year 2030.

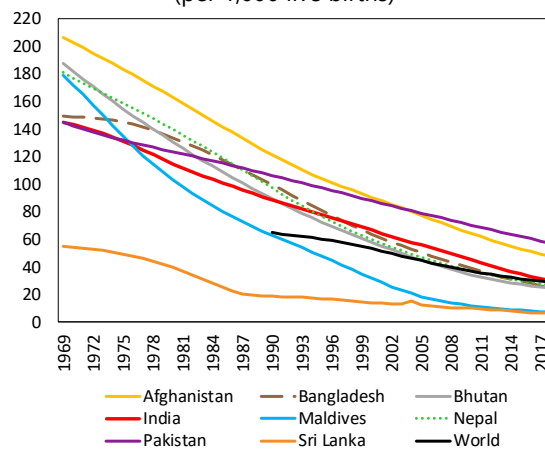
In the next section, the paper documents progress on these five sectors for India relative to South Asian countries and other large emerging markets. Section 3 reports the estimate of the additional spending that would be required to make substantial progress towards the SDGs in India. The data collection and validation, carried out in New Delhi in 2019, and the analysis presented in this paper use 2019 as base year for the analysis—thus, the available data does not enable accounting for the potential effects of COVID-19. Section 4 briefly discusses comparable additional spending estimates for the region, and Section 5 concludes and reflects on the potential implications of the pandemic for the SDGs in South Asia.

II. BACKGROUND AND CONTEXT

A. Health

All countries in South Asia have seen a steady improvement in health outcomes over the past 50 years. Sri Lanka and the Maldives outperform other South Asian countries as well as the world's average in health outcomes, with Sri Lanka having the lowest under-one-year-old infant mortality in South Asia since the early 1970s (Figure 1), and the Maldives catching up with Sri Lanka in recent years. Other countries—in particular, Pakistan since the 1990s, and Afghanistan—lag peers and, albeit exhibiting continued improvement, have infant mortality levels that double the current world average.

Figure 1. South Asia: Evolution of Infant Mortality Rate¹
(per 1,000 live births)



Source: World Bank (2020).

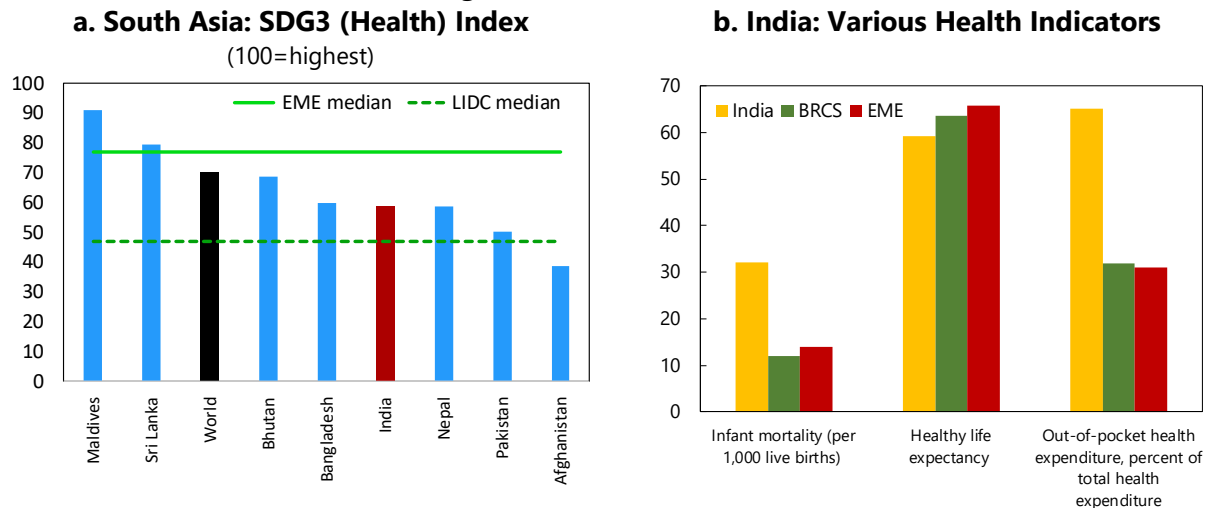
1/ Refers to mortality of children under one year of age.

³ Similar studies have been carried for Benin and Rwanda (Prady and Sy, 2019), Nigeria (Soto, Moszoro, and Pico, 2020), and Pakistan (Brollo and Hanedar, 2021); however, this is the first in-depth costing exercise presented along with its regional comparators.

India has also made noteworthy strides in health outcomes. Infant mortality stands at around 30 deaths per 1,000 live births, similar to the world average, compared to about 140 deaths per 1,000 live births in the early 1970s. Mortality rates of children under five years old dropped from 95 to 37 deaths per 1,000 live births in 2000–18, and 2018 infant mortality is also less than half the rate of 25 years ago. Significant progress has also been made in maternal mortality, which declined by 77 percent from 1990 to 2016 (Government of India, Ministry of Health and Family Welfare, 2018).

Yet, most countries in the South Asia region have a long way to go toward the health SDG. To assess this, we examine performance in terms of an index published in the annual Sustainable Development Report (e.g., Sachs et al., 2019) for each of the 17 goals, where index values of 0 and 100 indicate worst- and best-possible performance, respectively. We also assess India's health outcomes against those in emerging markets and in particular against other BRICS countries (Brazil, Russia, India, China, South Africa), deemed emerging economic powerhouses. As Figure 2a shows, only the Maldives and Sri Lanka have an SDG3 index above the world average and above the median of emerging market economies.⁴ In India, and despite past progress, health outcomes measured with the SDG3 index (or other indicators displayed in Figure 2b) are below the median of emerging economies and still behind the country's own targets. For example, current under-five mortality, at 37 per 1,000 live births, is more than three times as large as the country's goal to have a mortality rate of 11 by 2030.

Figure 2. Health Outcomes



Source: IMF staff calculations using Sachs et al. (2019).
Note: "World" is the simple average across all countries in the world for which the index is available.

Sources: IMF staff calculations using IMF FAD Expenditure Assessment Tool (Garcia-Escribano, Mercedes and Liu, 2017) and World Bank (2020).
Note: BRCS includes Brazil, Russia, China, and South Africa. EME refers to emerging market economies.

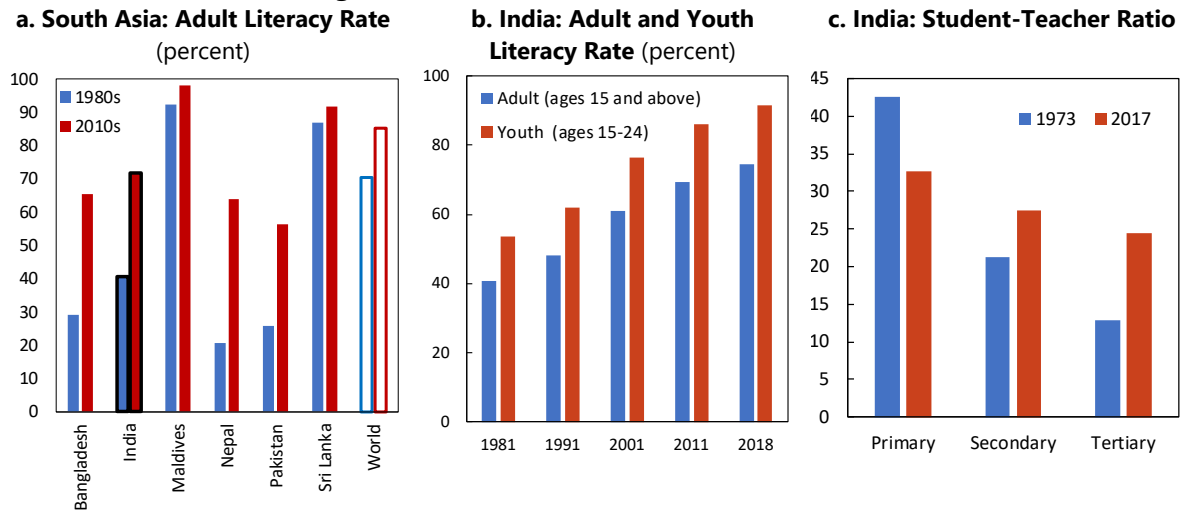
⁴ The SDG3 index comprises 14 health variables relating e.g. to mortality rates, life expectancy, incidences of diseases, access to vaccines and other health services, etc.

B. Education

In the last decades, all countries in South Asia have improved their education outcomes. Since the 1980s, the adult literacy rate doubled or tripled in Bangladesh, India, Nepal, and Pakistan (Figure 3a). At present, Sri Lanka and the Maldives have literacy rates above 90 percent, while other countries lag the world's average.

India's growth into an emerging market economy has been accompanied by increased levels of education. The share of the literate among all adults increased from 41 percent in 1981 to 74 percent in 2018 (Figure 3b). The economic gains of past decades have gone hand-in-hand with better education service delivery, including through the reduction in the student-teacher ratio at the primary level (Figure 3c). Still, nearly 45 percent of the population has education only at or below the primary level (NSO, 2019). While the expansion in the participation of youth in higher grade levels is welcome, it has put pressure on service delivery at the secondary and especially tertiary levels, resulting in rises in the student-teacher ratio.

Figure 3. Evolution of Education Outcomes

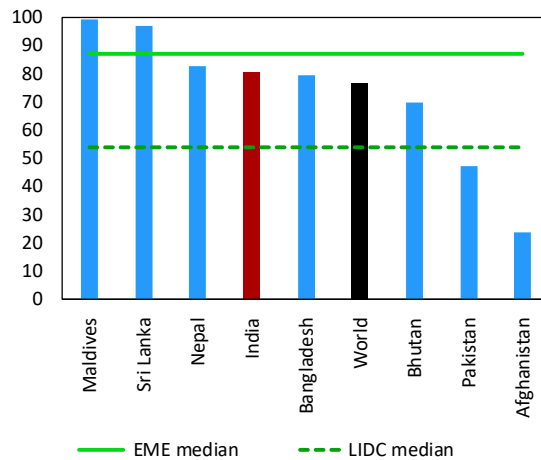


Source: IMF staff calculations using World Bank (2020).

Despite progress, educational outcomes in most South Asian countries lag emerging economy peers (Figure 4). South Asian countries span a wide spectrum in educational performance. Only the Maldives and Sri Lanka are close to attaining an SDG4 index of 100 and well exceed the emerging economy median of 87.⁵ At the same time, two countries—Pakistan and Afghanistan—even fall short of the low-income developing countries median index of 54. India's value at 80.2, falls short of the median index for emerging economies, which is likely related to the relatively large class sizes as well as gaps in pre-primary and tertiary enrollment. The student-teacher ratio is higher than in Brazil and China, and the enrollment ratio for the population ages 3–23 years is also below that of Brazil and China. India's own goal is to achieve a 100 percent adjusted net enrollment for grades 1–10 by 2030 (Government of India, NITI Aayog, 2018).

⁵ The SDG4 index for non-OECD countries is based on three measures: youth literacy, primary enrollment, and secondary completion rates.

Figure 4. South Asia: SDG4 (Education) Index
(100=highest)



Source: IMF staff calculations using Sachs et al. (2019).

Note: "World" is the simple average across all countries in the world for which the index is available.

C. Water and Sanitation

South Asia is rapidly improving access to water and sanitation. South Asian countries have gradually expanded access to basic drinking water, with several of them reaching almost universal access (Figure 5). In India, almost 90 percent of its rural population and all its urban population had access to basic water in 2019, a substantial improvement from below 80 percent in both categories in 2000, especially considering the population growth in the past two decades. Likewise, in basic sanitation, India has also seen impressive improvements, with 97 and 98 percent of the rural and urban population, respectively, being served in 2019. Meanwhile, access to safely managed water services in rural areas increased from 40 percent in 2010 to 56 percent in 2019 and urban areas from 73.5 percent in 2010 to 75.1 percent in 2019. Another important achievement in India has been ending open defecation.⁶

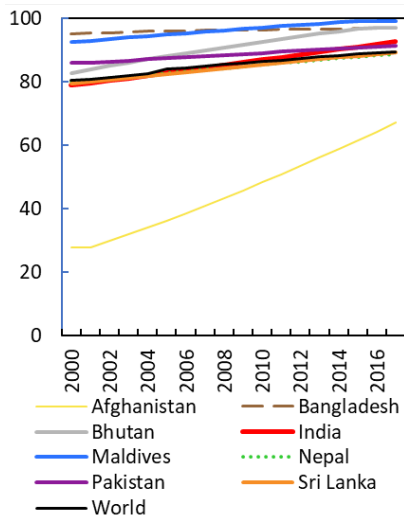
However, pockets of hygiene deprivation remain. Many households have only access to public sources of water, and exclusive access to drinking water in the house premises remains a privilege. The challenge in most South Asian countries is to improve the quality, accessibility, and safety of water and sanitation services (Figure 6). There is a persistent 30 to 60 percent gap in access to safely managed water and sanitation in the region.⁷ In India, there is room for improvement even in basic sanitation, as 29 percent of the rural population and 15 percent of

⁶ After accounting for the construction of over 114 million household toilets, the government reported 100 percent toilet coverage in October 2019, up from 39 percent in October 2014 (<https://sbm.gov.in/sbmdashboard/Default.aspx>).

⁷ The SDG6 index synthesizes variables on access to basic drinking water, access to basic sanitation, freshwater withdrawal, groundwater depletion, and treated wastewater. See Sachs et al. (2019) for further details.

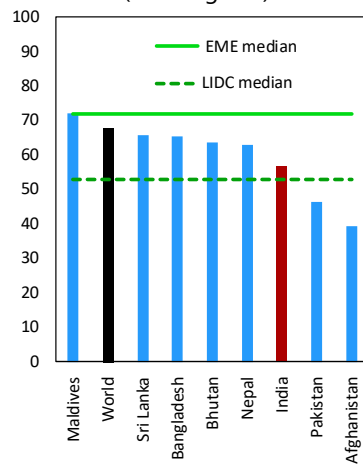
the urban population do not practice basic hygiene nor have access to such services. India lags peers in safely managed water and sanitation, especially in rural areas (Figure 7).⁸

Figure 5. South Asia: Access to Basic Drinking Water¹
(percent of population)



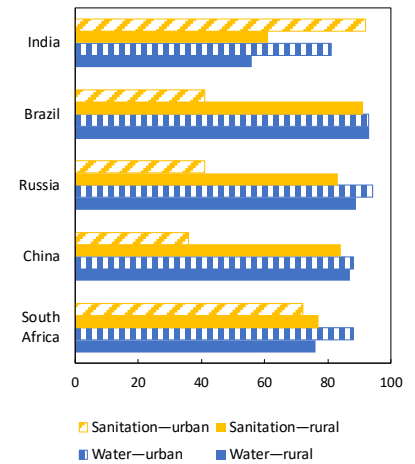
Source: World Bank (2020).

Figure 6. South Asia: SDG6 (Water and Sanitation) Index¹
(100=highest)



Source: IMF staff using Sachs et al. (2019).

Figure 7. Safely Managed Water and Sanitation in BRICS Countries, 2016²
(Percent of population)



Source: IMF staff calculations based on data from the World Bank.

1/ “World” is the simple average across all countries in the world for which the index is available.

2/ BRICSs include Brazil, Russia, India, China and South Africa.

D. Electricity

Access to electricity, a key requirement for a modern economy, has been steadily increasing across South Asia during the last decade (Figure 8). During 2002–17, India tripled its installed capacity from 108 gigawatts (GW) to 327 GW. Most of the added installed capacity came from thermal and hydro power plants, with an increasing share of renewable energy sources in recent years. During the same period, the per capita energy consumption increased from 559 kilowatt-hours (kWh) to 1,122 kWh. Recently, the peak demand not met declined from 12,159 megawatts (MW) (9.0 percent of peak demand) in 2012 to 2,608 MW (1.6 percent of peak demand) in 2017, reflecting a substantial improvement in the quality of electricity service (Government of India, Ministry of Power, 2018).

Several South Asian countries display high achievement in the electricity SDG sub-index (Figure 9). In only one country—Pakistan—is electricity access below 80 percent as well as below the median for emerging market economies. There remains room for most South Asian countries to increase capacity, reliability, and sustainability of electricity provision. For instance, India’s electricity consumption per capita falls behind peers. With per capita consumption of 1,181 kWh

⁸ The fact that the figure for safely managed sanitation is high for India may be related to different definitions used for classification between the Indian authorities and the United Nations.

Figure 8. South Asia: Access to Electricity
(percent of population with access)

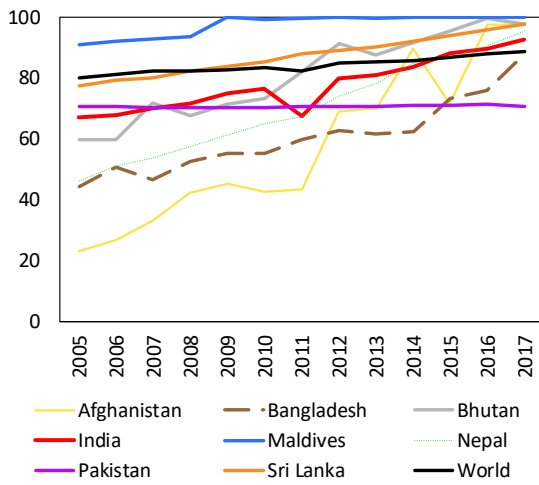
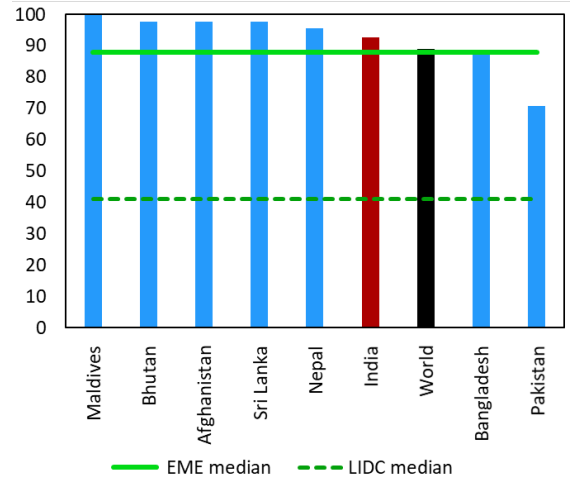


Figure 9. South Asia: SDG7 (Electricity) Index¹
(percent of population with access)

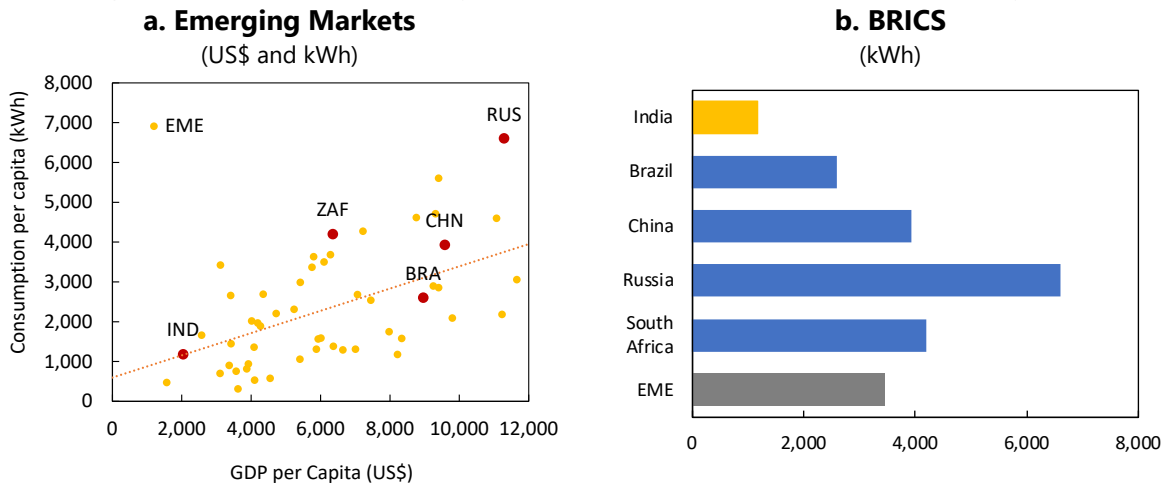


Source: World Bank (2020).

Source: World Bank (2020).

1/ The chart reflects only the sub-index of SDG7 capturing percentage of population with access to electricity. "World" is the simple average across all countries in the world for which the index is available.

Figure 10. GDP and Electricity Consumption (per capita, 2018 or latest year)



Source: IMF staff calculations based on data from World Bank (2020).

Note: The dotted line in Figure 10a represents the fitted line of the relationship between electricity consumption per capita and GDP per capita, calculated by ordinary least squares (OLS) regression. Data for India is from 2018; data for Brazil, Russia, China, and South Africa is from 2016.

in 2019, India is in line with its expected provision of electricity given its GDP per capita (Figure 10a), but it lags other BRICS (Figure 10b).⁹ While India has accomplished practically universal supply of electricity to its approximately 700,000 villages, universal and reliable access

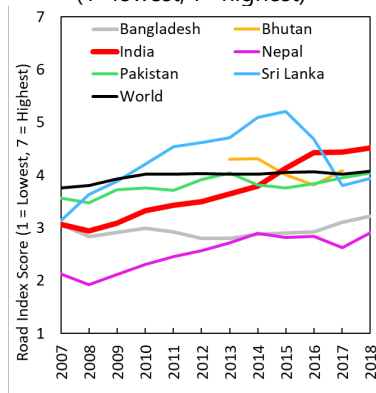
⁹ BRICS include Brazil, Russia, India, China and South Africa.

has yet to be extended to every household.¹⁰ Additionally, India intends to become energy self-sufficient and independent from imported power inputs.

E. Roads

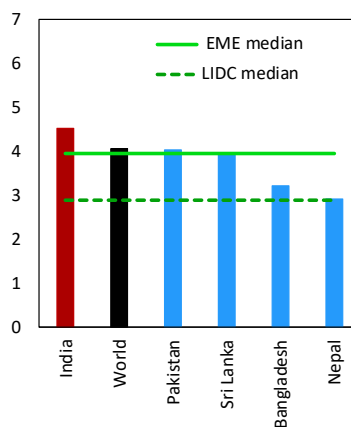
South Asian countries have undertaken a major effort in extending and upgrading their road systems over the past decade (Figure 11). India appears to have made the largest strides, currently exhibiting the world's third largest road network.¹¹ In the years 2011–17, India added on average more than 130,000 kilometers per year to its road network (Government of India, Ministry of Road Transport and Highways, 2019) with notable efforts including developing roads around industrial corridors and the implementation of rural road programs.

Figure 11. South Asia: Evolution of Road Infrastructure Index¹
(1=lowest, 7=highest)



Source: World Economic Forum (2019). Data not available for Afghanistan and the Maldives.

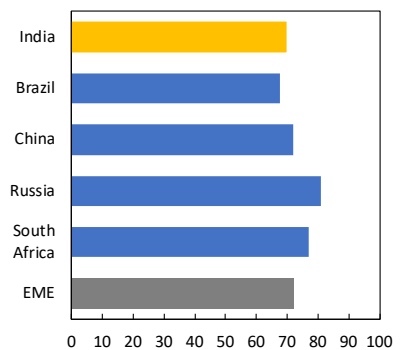
Figure 12. South Asia: Road Infrastructure Index 2019¹
(1=lowest, 7=highest)



Source: World Economic Forum (2019). Data not available for Afghanistan, Bhutan, and the Maldives.

Figure 13. Rural Access Index for BRICS and EMEs

(percent of rural population within two kilometers of an all-weather road)



Source: IMF staff calculations using Government of India, Ministry of Road Transport and Highways (2018a); Mikou et al. (2019), and World Bank.

1/ "World" is the simple average across all countries in the world for which the index is available.

Nevertheless, the quality of road infrastructure remains low across the South Asia region. The infrastructure index places South Asia, except for India, below the world average (Figure 12).¹² Rural roads in India account for 71 percent of the total road length,¹³ but only about 70 percent

¹⁰ For example, two severe power blackouts affected most of Northern and Eastern India on July 2012. See "[Massive power cut hits India](#)," BBC News, January 2, 2001.

¹¹ See <https://www.roadtraffic-technology.com/features/featurethe-worlds-biggest-road-networks-4159235/> (accessed December 2019).

¹² The survey-based infrastructure index obtains information from expert respondents on the quality of overall infrastructure in a country, and ranges from 1 (worst possible) to 7 (best possible).

¹³ Of total roads length, rural roads account for 71 percent, district roads for 10 percent, urban roads for 9 percent, project roads for 5 percent, state highways for 3 percent, and national highways for 2 percent (Government of India, Ministry of Road Transport and Highways, 2019).

of the rural population have access to all-weather roads within two kilometers (Figure 13). Closing the rural road infrastructure gap and increasing rural access to at least 90 percent will be critical for further development in India as well as in the rest of the South Asian region.

III. RESULTS ON ADDITIONAL SPENDING IN INDIA NEEDED TO MEET THE SDGS

This section presents the estimates of the additional public and private spending required to make substantial progress towards the SDGs in India following the methodology developed by Gaspar et al. (2019). The methodology is based on an input-outcome approach, which assumes that development outcomes are a function of a mix of inputs. For each country, the methodology sets the levels of key inputs and the associated unit costs at the values observed in countries with similar levels of GDP per capita that reach high development outcomes (Gaspar et al., 2019). The costing approach used in the paper does not systematically account for cross-sectoral (and cross-country) inter-dependence and spillovers.¹⁴

For the health and education sectors, the additional spending is estimated using as benchmark the input variables (e.g., student to teacher ratio in the case of education) in peer countries that exhibit relatively good performance in these two sectors, and also taking into account India-specific factors such as demographics and the level and growth of GDP per capita. Peer countries for India in this analysis are emerging market economies, including the other BRICS (Brazil, Russia, China, and South Africa). The estimates, as indicated in Gaspar et al. (2019), are consistent with increasing technical efficiency. Countries that perform well also tend to be among the most efficient. Thus, when assigning the input levels observed in countries that perform well today to India, our spending estimates for high performance assume better spending. Should improvements in efficiency not take place, the spending required to reach the SDGs would be larger.¹⁵ Results are presented as the annual additional spending in 2030 in percentage points of GDP compared to the current level of spending as a share of GDP. For physical capital, additional spending in percentage points of GDP corresponds to the annualized spending required to close infrastructure gaps between 2019 and 2030. The costing estimates for electricity and roads assume a linear five percent depreciation and reinvestment rate; for water and sanitation, given its longer depreciation period, a one-off investment in capital stock was assumed. More methodological details for each sector are presented in the Appendix.

A. Health

Enhancing health outcomes in India in line with achieving the health SDGs would require a sizable increase in health spending. Health spending in India currently stands at 3.7 percent of GDP and falls short of levels spent in the BRICs and EMEs (Figure 14a). This level of spending reflects a lag in doctors and hospital beds per 1,000 inhabitants (Figure 14b). For India to achieve substantial progress towards the SDGs by 2030, it will need to more than double health sector

¹⁴ For instance, increasing health spending may be useful for school attendance, and increasing spending on physical infrastructure might be helpful for improving health outcomes, e.g., through wider access to health facilities. The cross-sectoral and cross-country inter-dependence and spillovers should be addressed with a DSGE model, which goes beyond the scope of this paper.

¹⁵ Considering how different levels of allocative efficiency across sectors would affect our results goes beyond the scope of this study, and could be explored in future research.

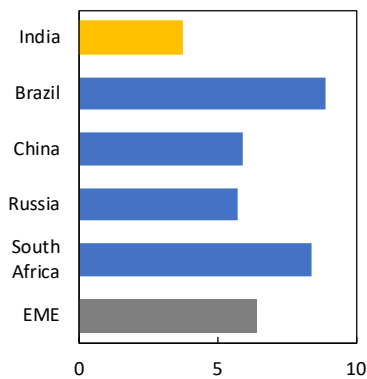
spending relative to its GDP (Table 1). Such additional spending of 3.8 percent of GDP would allow India to expand the number of medical staff, while moderately slowing the growth of personnel compensation, containing the ratio of doctor salaries to GDP per capita from 7.8 to 6.6—the current ratio is higher than for economies in the same income group that are able to achieve strong health outcomes.¹⁶ Meanwhile, capital and recurrent spending other than on the health-workers’ wage bill should increase as a percent of total health spending. The expansion in health spending would need to be undertaken mostly by the public sector as the country currently relies heavily on private outlays (67 percent of total health spending). The spending increase could help cover an expansion of India’s health protection scheme, PMJAY, to prevent non-included but vulnerable individuals from falling into poverty due to illness and private health costs¹⁷ (see Appendix I for methodological details).

As stated earlier and illustrated in Figure 14.c, India will need to not only spend more on its health system, but spend more efficiently. Institutional changes and strengthening public financial management could contribute to increasing the efficiency of outlays. Providing greater autonomy to facility managers could foster greater efficiency in the sector. Rigidities imposed on clinic and hospital managers limit their ability to allocate funding in their facility in the most appropriate way for service delivery (Barroy et al., 2019). Strengthening budget preparation will also improve health units’ absorptive capacity and mitigate the problem of these units often having to return unused funds.

Figure 14. Performance in the Health SDG, in Income-Group and Regional Comparison

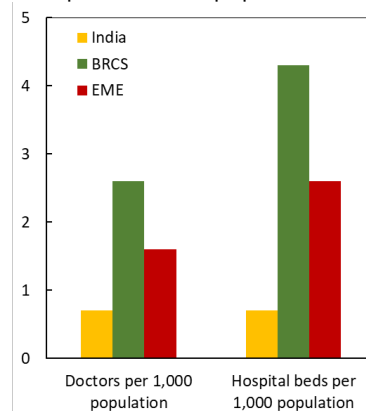
a. Total Health Spending

(percent of GDP)

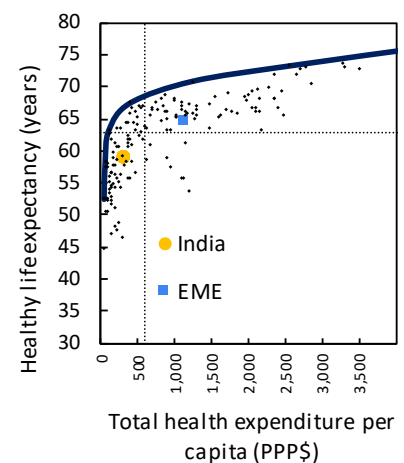


b. Health Inputs

(per thousand population)



c. Health Efficiency Frontier



Source: IMF staff estimates using Sachs et al. (2019) and IMF FAD Expenditure Assessment Tool.

Note: In panel (c), the dotted lines signify the averages for emerging Asia.

¹⁶ A potential concern of brain-drain resulting from slowing the growth of salaries of medical staff is mitigated by the fact that strong-performing peers in the same income group appear not to face this problem substantially.

¹⁷ Today India’s health insurance scheme, at about 0.1 percent of GDP, remains small in size and scope.

Table 1. India: Estimated Health Spending Needed for High Performance in Health SDG

	GDP per capita \$3,000 - \$6,000			India	
	All	Low performers	High performers	2017	2030
<i>Main factors</i>					
Doctors per 1,000 population	1.2	0.8	1.7	0.7	1.6
Other medical personnel per 1,000 population	6.0	5.6	6.3	2.9	5.4
Share of population under 1 and 60 and older	12.0	10.9	19.0	11.4	14.1
Doctors per 1,000 population age 1-59	0.9	0.7	1.2	0.6	1.2
Other medical personnel per 1,000 population age 1-59	4.2	4.2	4.1	2.3	4.1
Doctor wages (ratio to GDP per capita)	7.1	7.1	6.6	7.8	6.6
Other current and capital spending (% total spending)	62.3	61.1	62.3	54.2	62.3
<i>Results</i>					
Health spending (percent of GDP)	6.9	6.6	7.0	3.7	7.5
Per capita spending (USD 2018)	285.6	258.6	350.2	68.9	315.1

Source: IMF staff estimates using Gaspar et al. (2019) methodology.

B. Education

India can achieve better education outcomes by 2030 without increasing the share of GDP devoted to education expenditures. As the student-age population is expected to shrink, India can increase the spending per student even if expenditures as a percentage of GDP decline. Education spending in 2030 as a share of GDP at 4.1 percent (lower than the current expenditures of 5.6 percent) would allow spending per student to increase by 37 percent by 2030—to an annual US\$ 674 per student from the current level of US\$ 491 (Table 2). Such expansion in spending per student might require a larger share of public sector in education, as private spending contributes 27 percent of overall spending—compared to peer countries with a strong sectoral record, with only 5 percent reliance on private spending (see Appendix II for details on the methodology).

Table 2. India: Additional Education Spending for High Performance in Education SDG

	GDP per capita \$3,000 - \$6,000			India	
	All	Low performers	High performers	2018	2030
<i>Main factors</i>					
Students per teacher ratio	19.0	20.6	16.5	26.9	16.5
Teacher wages (ratio to GDP per capita)	2.5	3.9	1.7	3.1	1.7
Other current and capital spending (% total spending)	38.9	39.0	35.7	52.1	35.7
Student age population (% total population)	39.0	40.9	33.1	38.3	31.9
Enrollment rate (preprimary to tertiary)	68.4	64.3	69.8	59.9	80.1
<i>Results</i>					
Education spending (percent of GDP)	5.7	8.2	3.7	5.6	4.1
Spending per student (USD 2018)	890.8	1,401.6	660.2	491.2	673.6
SDG4 Index	77.8	75.3	88.2	80.2	

Source: IMF staff estimates using Gaspar et al. (2019) methodology.

While there is no need to spend more in education relative to GDP, India needs to spend more efficiently. Reallocation of resources by reducing wage growth towards bringing on board more teachers will support higher enrollment and reduce class size. The student per teacher ratio is 16.5 in countries with strong education outcomes compared to 27 in India today. As strong economic growth continues, teachers' wages would have to increase at a slower pace than GDP per capita. India's teachers' wages are three times its GDP per capita, which is distinctly higher

than teachers' wages in high-performing countries among India's peers that are less than twice the GDP per capita. More effort also needs to be exerted to reduce absenteeism of those teachers already employed if resources are to be used efficiently, for example through more systematic monitoring—using both top-down (e.g. through surprise inspections) and bottom up (through active parent-teacher associations) mechanisms (Muralidharan et al., 2017).

Beyond country-wide levels, the geographic and socio-cultural distribution of educational opportunities requires greater attention. The SDG4 India Index across states/union territories ranges widely, from 36 to 87 (Government of India, NITI Aayog, 2018). Discrepancies also prevail across social groups. For example, scheduled tribes' gross enrollment rate in higher education is 10 points lower than the overall average (Government of India, Ministry of Finance, 2019). Important progress by the government needs to be acknowledged in bringing about gender equity in enrollment. In fact, gross enrollment rates are higher for girls than boys at all levels other than higher education (Government of India, Ministry of Finance, 2019). Being attentive to these distributional concerns will both improve targeting of spending for more efficient achievement of India-wide goals, as well as address crucial concerns of equity.

C. Water and Sanitation

India can achieve universal coverage of water and sanitation with large health externalities at a relatively low cost. Using the World Bank's WASH methodology in Hutton and Varughese (2016), we estimate the cost to provide universal safely managed access to water and sanitation at US\$ 106 billion over 2020–30, which on an annualized basis is equivalent to 0.17 percent of GDP in 2030, including depreciation. The bulk of the burden comes from sanitation in rural areas (see Appendix III for details on the methodology).

Beyond resources, institutional and technical capacity constraints need to be addressed. Sub-national governments are responsible for water and sanitation, but often do not have the capacity to set the institutional framework, especially in rural areas. Other areas for improvement include enhancing the management of tariffs—unsystematic application of tariffs might be straining the finances of local governments—and improving the mapping of the existing network, which can bring efficiency gains as well as facilitate maintenance and network expansion. In addition, efforts should continue to improve wastewater treatment—only around 30 percent of wastewater is treated—to prevent the deterioration of the groundwater.

D. Electricity

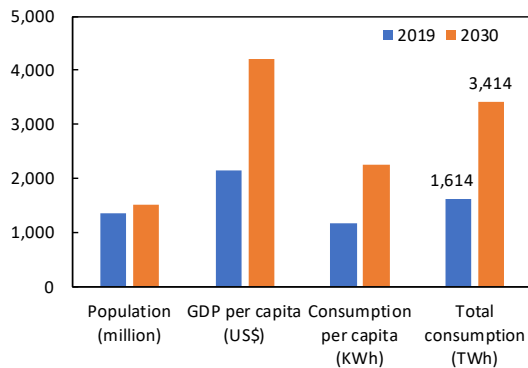
Generation capacity needs to keep up with population and economic growth to grant full access to electricity (SDG Indicator 7.1.1). To provide universal electricity access to a larger population of 1.5 billion and increase electricity per capita consumption to keep up with GDP growth, there will be a need to expand installed capacity (Figure 15). The cost of additional generation capacity is estimated at US\$ 1,140 per kW (Table 3), plus markups of 50 percent for transmission and 50 percent for distribution.¹⁸ The average investment cost per kW of capacity is calculated as the weighted average of unit costs for the different types of energy sources, using the shares of

¹⁸ Based on interviews with experts from India's Ministry of Power, the costs in transmission and distribution costs are assumed to add 50 percent each to investment costs in capacity.

projected installed capacity in the power mix as the weights. At an overall unit cost of US\$ 2,280 per kW including generation, transmission, and distribution costs, India will have to invest an aggregate of US\$ 469 billion from public and private sources to meet electricity demand, which on an annual basis is equivalent to 1 percent of GDP in 2030, including replacement costs.

India has embarked on an ambitious program to shift its power mix toward renewable energy. According to the National Electricity Plan (Government of India, Ministry of Power, Central Electricity Authority, 2018), renewable energy sources will increase from 23 percent of total installed capacity in 2019 to 44 percent in 2027 (Table 3 and Figure 16). The major renewable energy sources include solar and wind, both of which will require investment in battery storage of 136 GWh due to their asynchronous (i.e., weather and time-dependent) nature. India is the third-largest CO₂ emitter, after China and the United States,¹⁹ thus the environmental advantages of increasing the share of renewables in the energy mix will be substantial at the global level.

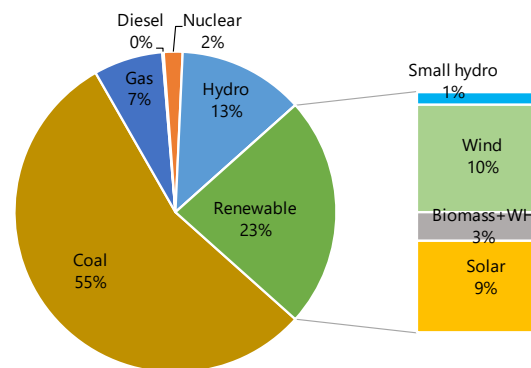
Figure 15. India: Electric Power Consumption, 2019 and Projections for 2030



Source: IMF staff calculations.

Note: Wh – Watt-hour. Our electricity consumption forecast of 2,257 kWh per capita by 2030 is higher than India's Central Electricity Authority forecast of 1,717–1,777 kWh due our assumption of higher income demand elasticity.

Figure 16. India: Installed Capacity, 2019 (percent)



Source: Government of India, Ministry of Power, Central Electricity Authority (2018).

Note: Data corresponds to October 2019.

¹⁹ See <https://www.weforum.org/agenda/2019/06/chart-of-the-day-these-countries-create-most-of-the-world-s-co2-emissions/>.

Table 3. India: Current and Target Installed Capacity Mix

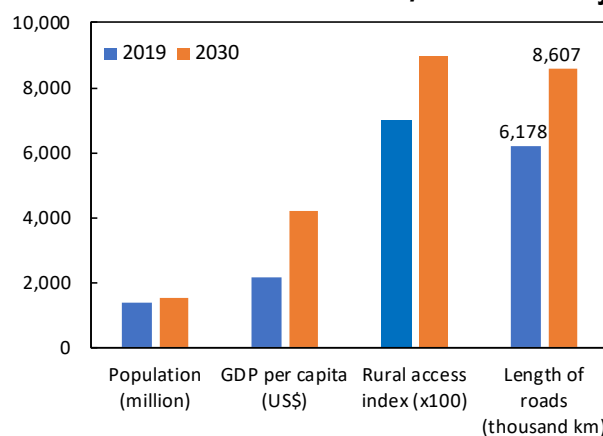
Source	2017			2022			2027			
	MW	Percent	Investment cost per kW (in US\$)	MW	Percent	Investment cost per kW (in US\$)	MW	Percent	Investment cost per kW (in US\$)	
Conventional	Coal + Lignite	193,001	59	868	217,302	45	1,056	238,150	38	1,285
	Gas	25,329	8	514	25,735	5	625	25,735	4	760
	Hydro	44,478	14	1,335	51,301	11	1,625	63,301	10	1,977
	Nuclear	6,780	2	1,335	10,080	2	1,625	16,880	3	1,977
	<i>Sub-total</i>	269,588	82		304,418	63		344,066	56	
Renewable	Solar Power	12,289	4	764	100,000	21	764	150,000	24	764
	Wind Power	32,280	10	833	60,000	13	833	100,000	16	833
	Biomass	8,296	3	792	10,000	2	792	17,000	3	792
	Small Hydro Power	4,380	1	868	5,000	1	1,056	8,000	1	1,285
	<i>Sub-total</i>	57,244	18		175,000	37		275,000	44	
Total	326,832	100	905	479,418	100	1,011	619,066	100	1,140	

Source: IMF staff calculations based on Government of India, Ministry of Power, Central Electricity Authority (2018).

Note: MW = Megawatts.

E. Roads

India will have to invest a significant share of its GDP to improve rural roads access. Gradually raising rural access to 90 percent by 2030 will require about 2.4 million additional kilometers of all-weather roads—an increase of 39 percent in road length (Figure 17). While construction costs vary by road characteristics (i.e., number of lanes and type of surface) and region (e.g., a third-tier all-weather road in the North may cost twice as much to build than in the South), we estimate an average cost per kilometer of about US\$ 509 thousand (Appendix IV). Thus, extending the road network by 2.4 million kilometers will require an aggregate investment of US\$ 1.2 trillion by 2030, which on an annualized basis is equivalent to 2.7 percent of GDP in 2030, including depreciation.

Figure 17. India: Main Road Statistics, 2019 and Projections

Source: IMF staff calculations based on Government of India, Ministry of Road Transport and Highways (2019).

Note: Projections assume rural access increases to 90 percent.

The estimated cost is a lower bound. First, India's goal is to achieve 100 percent of households connected by all-weather roads under the Pradhan Mantri Gram Sadak Yojana (PMGSY) program by 2030 (Government of India, NITI Aayog, 2018): i.e., the government's goal is more ambitious than the target of 90 percent of the rural population with access, assumed in the IMF's additional spending estimations for emerging market economies by Gaspar et al. (2019). Second, our analysis does not account for the additional investments to make infrastructure resilient to climate change (e.g., to more severe floods). The Asian Development Bank has estimated that climate-adjusted costs could add between 1.2 and 1.4 percent of GDP annually to their base estimations (Asian Development Bank, 2017).

Land and financing reforms and strengthening subnational institutions are also essential to expedite road infrastructure development. Many infrastructure projects have stalled because of difficulties in land acquisition or the slow pace in obtaining government clearances (Rajan, 2019). Addressing these weaknesses could include initiatives such as enhancing procurement practices (i.e., increasing openness and transparency and limiting red tape) and improving risk allocation (i.e., shifting some of the risks related to land acquisition to the government while maintaining the construction and commercial risks in the private sector). Sub-national institutional and technical capacity requires buildup to cope with road network expansion, as about 90 percent of the road budget is administered at the sub-national level. While central road agencies are well equipped and staffed, many state and local level administrations need to increase institutional and technical capacity to accelerate road network development.

The private sector has emerged as a key player in the development of road infrastructure. Many private players are entering the business through the public-private partnership model. In addition, the National Infrastructure and Investment Fund (NIIF) was formed to facilitate international and domestic funding in infrastructure and attract equity capital from both international and domestic sources for infrastructure investments in commercially viable projects. Likewise, the latest budget for 2018–19 highlights the use of innovative monetizing structures like Toll-Operate-Transfer (TOT) and Infrastructure Investment Trusts (InvITs) to monetize public-sector assets, including roads.

IV. RESULTS ON ADDITIONAL SPENDING REQUIRED TO MEET SDGs IN SOUTH ASIA

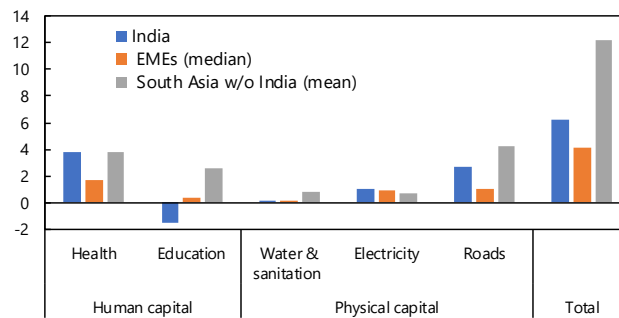
This section places the results on costs to meet the SDGs in India into a regional context. It compares them with the corresponding costs for other South Asian countries. The analysis for India presented in the previous section is based on an in-depth case study, involving extensive discussions with the authorities and based on the most up-to-date data. For other countries, the estimates follow the same methodology but have not been validated through discussions with and the latest data from the respective country counterparts. Given these estimates are preliminary in nature, Figure 18 presents the average for a group of countries including Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan, and Sri Lanka.

Spending to meet the health and electricity goals in India are somewhat comparable to those in the rest of South Asia. The additional expenditures to perform well on the health SDG in India outstrip the corresponding costs associated with any of the other four selected SDGs. This estimate is quite similar to that of other South Asian countries, on average. India's additional

spending to achieve a high performance in the electricity sector is also proximate to (and only somewhat higher than) the average across South Asia.

Spending needed for the education, water and sanitation, and roads SDGs are distinctly lower in India than elsewhere in South Asia. On average, South Asian countries' additional costs to meet the education SDG is about 2 percent of GDP, with some countries facing additional costs of more than three times this average. This is higher than for India—which has a lower spending requirement in terms of GDP in 2030 than its current spending—and for the average emerging economy. Overall, additional spending in water and sanitation is relatively low when compared with the spending to meet most other selected goals. Additional spending on water and sanitation is also lower in India and South Asian countries relative to emerging economies. In contrast, the South Asian region will need to make the substantial investments in road infrastructure. The average annual additional spending in the region for roads is about 4.3 percent of GDP, 1.6 percent higher than the additional annual spending required to meet the road SDG estimated for India and over four times that for emerging economies.

Figure 18. India: Spending in 2030 in Selected SDG Sectors
(Percent of 2030 GDP)



Source: IMF staff calculations and Gaspar et al. (2019).

Note: South Asia, excluding India, includes Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka.

V. CONCLUSION

We estimate that making substantial progress in critical SDG sectors in India would require additional annual spending of about 6.2 percentage points of GDP in 2030. While this is significant in size, it appears moderate when compared to the estimated additional cost in other South Asian countries of about 11.3 percent of GDP. On the other hand, however, additional annual spending India is above that of the median emerging economy, at about 4 percentage points of GDP (Figure 18) as estimated by Gaspar et al. (2019).

The estimates assume that India and South Asian countries would be able to combine different inputs efficiently to deliver across the analyzed sectors. This would require important reforms. For example, in education, expanding enrollment in pre-primary and tertiary levels as well as reducing class sizes would require increasing the number of qualified teachers. In health, in addition to raising the number of qualified health workers, it is critical to address the financial vulnerability to health care shocks. In infrastructure, raising institutional and technical capacity remains key, particularly in largely rural states. Broader public financial management reforms are

also called for to strengthen the efficiency of spending. For example, while some states have begun to produce medium-term fiscal projections as part of the budget, the central government and all states could do so too, as well as strengthen the performance-orientation of budgeting and develop more forward-looking fiscal strategies.

As the analysis for this paper was undertaken before the COVID-19 pandemic, it does not incorporate its potential impact on the spending needed to reach the SDGs. Evidence is already mounting that COVID-19 will have ripple effects for years to come in economies throughout the world, including in South Asia, and as such, it will also have implications for the SDG agenda. 2020 saw an annual rise in the extreme poverty rate for the first time in over 20 years, with an estimated additional 119 to 124 million people pushed into poverty—60 percent of whom are in southern Asia (UN, 2021). Countries could see a reduction in the available fiscal space to finance the SDGs due to the higher debt, a decline in revenues as economic activity stalls, and higher expenditures to fight the virus and its economic and social consequences, making the achievement of the SDGs in human capital development and infrastructure more challenging (IMF, 2021).

Cost estimates for reaching the SDGs may increase because of progress being set back by the pandemic. For instance, school closures are likely to result in children falling behind in learning (especially since home-schooling cannot be done effectively in particular by households lacking skills, means, or time). In India, for example, an estimated 320 million children have been affected by pandemic-induced school closures (Sahni, 2020). This will increase the costs to achieve the education SDG. Health personnel and supplies to fight the virus could be diverted from other health needs, and demand for health services could decline when the population fears the risk of contagion in medical facilities. Both factors may compromise progress on critical SDG health indicators. A study on 14 countries, among which six are in South Asia, found that such resource diversion has already shown detrimental effects on the maternal mortality rate (De Beni and Maurizio, 2020). Electricity consumption could face a temporary sharp dip due to dropping demand emanating from the lockdowns and cascading effects on stalled economic activity. And the significant resource needs for the emergency health response to the pandemic, for social assistance, and for support to firms, could be expected to temporarily hold back public investment, including in road infrastructure.

On the other hand, emergency financing, debt relief, and budget reallocations that are boosting health-related spending to fight the pandemic, if sustained over time, could accelerate the achievement of some SDG targets. Increases in health spending may improve indicators concerning access to vaccines, health personnel, and mitigating global health risks. Similarly, efforts to contain the virus may lead to advancing progress on the SDG related to water and sanitation by triggering increases in the proportion of the population using safely managed sanitation services, including hand-washing facilities with soap and water (WHO, 2020).

Future research could usefully update the analysis to account for the pandemic, drawing on additionally collected data from 2020 onwards on key cost-drivers, inputs, and spending in the five sectors and other demographic and economic variables.

The analysis can be expanded in additional ways. Given the cooperative federal structure and the diversity across states and union territories, it would be insightful to review the challenges in

achieving the SDGs at the subnational level. To this end, the authorities have taken important steps toward the localization of SDG efforts, including promoting convergent implementation structures and deploying regional monitoring systems. Finally, this paper's analysis discussed qualitatively what reforms may be needed for India to achieve higher levels of efficiency in spending that underlies the costing method. Further work could estimate the effect on spending needs of relaxing assumptions on technical efficiency in spending, and quantify the increases in efficiency commensurate with the stated spending needs to reach the SDGs.

METHODOLOGY AND DATA BY SECTOR

Appendix 1. Health Care

Health expenditures (as a percent of GDP), E , can be expressed as an identity:²⁰

$$E = 10w \frac{D + 0.5M}{100 - E_{other}}$$

where w refers to doctors' annual wages as a ratio to GDP per capita, D and M are the numbers of doctors and other medical personnel, respectively, per 1,000 population, and E_{other} pertains to all spending besides the health workers' wage bill as a percent of total expenditures in education. The number 0.5 in the equation reflects an assumption that wages of other health service providers are about half that of doctors, based on cross-country data²¹ on wages of specialists, general practitioners, and nurses (this assumption is also used in Gaspar et al., 2019). The rationale behind this equation is that total expenditures are a function of the health service providers wage bill (i.e. wages times the supply of personnel) divided by the share of the wage bill in total spending.

The spending needed in 2030 by India to perform well in the health SDG are derived as the level of expenditures that India would incur in light of its projected demographics (in particular, the projected population share of infants and the elderly) in 2030 and today's levels for the health cost-drivers observed in the high performing countries in the health sector among India's peers (which include emerging markets, as noted in the main text). These cost drivers include doctors' wages, the number of doctors relative to the population size, the number of other medical personnel relative to the population size, and health spending other than the health workers' wage bill (as a share of total health spending). The approach of matching India's 2030 cost drivers to today's level of the high performers is seen in the corresponding columns of Table 1. Table A1.1 presents the data sources and computation of demographic factors and cost drivers for India today (latest available are from 2016–17).

²⁰ This is a rearrangement of the equation in Gaspar et al. (2019, p.27).

²¹ Given limited data availability, this estimate is based on OECD data, and reflects the average ratio across countries from 2000 to 2020 between specialists' and nurses' wages (0.46) and between general practitioners' (GPs') and nurses' wages (0.58). The average of these two ratios is 0.52. On the one hand, the two ratios are likely to be lower for lower-income countries, but on the other hand there are usually many more general practitioners than specialists, biasing the simple average of the two ratios upward. The two biases are expected to at least partially cancel each other out.

**Table A1.1. India: Computation and Data Sources for Variables Used in Health SDG
Additional Spending Estimation**

Variable	Computation, or data source
<i>D</i>	$0.9 * 1000 * \text{number_of_doctors} / \text{population}$
	Assumption that only 90% of registered doctors are practicing, due to emigration, incapacity, or other factors.
Number of doctors	Government of India, Ministry of Health and Family Welfare (2018)
Population	Population in 2017 from UN (2019)
<i>M</i>	$1000 * (\text{dentists} + \text{nurses} + \text{Ayush_practitioners}) / \text{population}$
Number of registered dentists	Government of India, Ministry of Health and Family Welfare (2018)
Ayush registered practitioners	Government of India, Ministry of Health and Family Welfare (2018)
Registered nurses	ANM + RN&RM + LHV
	Government of India, Ministry of Health and Family Welfare (2018)
<i>E_{other}</i>	$[\text{total_spending} - (\text{compensation_of_employees_non_administrative} + \text{wage_bill_component_of_current_transfers_to_local_bodies_non_admin})] / \text{total_spending}$
	MoSPI (2019)

Appendix 2. Education

Education expenditures (as a percent of GDP), E , can be expressed as an identity:

$$E = \frac{w}{STR} e \frac{SAP}{100 - E_{other}}$$

where w refers to teachers' annual wages as a ratio to GDP per capita, STR is the student-teacher ratio, e signifies the enrollment rate (i.e. the number of students as a percentage of the student-age population), SAP indicates the student-age population as a percent of total population, and E_{other} , pertains to all education spending besides the teacher wage bill as a percent of total expenditures in education. Total education expenditure is therefore a function of the teachers' wage bill (i.e., wages times the supply of teachers) divided by the share of the wage bill in total education spending. The supply of teachers, in turn, is derived as the number of students (enrollment rate times the student age population) divided by the student teacher ratio.

The spending needed in 2030 in India to perform well in the education SDG derived taking into account India's projected demographics (student-age population) in 2030 and today's levels of the education cost-drivers of the high performing countries among India's peers. These cost drivers include teachers' wages, the student-teacher ratio, the enrollment rate, and education spending other than the teacher wage bill as a share of total education spending. The approach of matching India's 2030 cost drivers to today's level of the high performers is seen in the corresponding columns of Table 2. Table A2.1 gives the data sources and computation of demographic factors and cost drivers (latest available are for 2017–18).

Table A2.1. India: Computation and Data Sources for Variables Used in the Education SDG Additional Spending Estimation

Variable	Computation, or data source
STR	number_of_students / number_of_teachers
Number of students	pre_primary_students + school_education_students + tertiary_students
Number of teachers	pre_primary_teachers + school_education_teachers + tertiary_teachers
Pre-primary students	attendance_rate_of_population_aged_3to5 * population_aged_3to5
School education students	Received from authorities
Tertiary students	Received from authorities
Attendance rate of population aged 3–5	NSO (2019): "Key Indicators of Household Social Consumption on Education in India", National Statistics Office, Ministry of Statistics and Program Implementation.
Population aged 3–5	UN (2019): "World Population Prospects", Population Division, Department of Economic and Social Affairs, United Nations
Pre-primary teachers	Pre-primary_students / 25; 25 is the student teacher ratio provided verbally by authorities as a rough estimate, in the absence of data
School education teachers	Received from authorities
Tertiary level teachers	Received from authorities
E_{other}	[total_spending – (compensation_of_employees_non_administrative + wage_bill_component_of_current_transfers_to_local_bodies_non_admin)] / total_spending MoSPI (2019)

(continued)

Variable	Computation, or data source
Wage bill component of current transfers to local bodies, non-administrative i.e. for direct service delivery (Rupees)	current_transfers_to_local_bodies_non_administrative * compensation_of_employees_non_admin / (total_spending_non_admin - current_transfers_to_local_bodies_non_admin)
<i>SAP</i>	MoSPI (2019)
Population aged 3–23	population_aged_3to23 / total_population
Total population	UN (2019)
<i>e</i>	Population in 2018 from UN (2019)
<i>E</i>	number_of_students / population_aged_3to23
Public spending (Rupees)	In education: (public_spending + private_spending) / GDP
Private spending (Rupees)	total_spending
Private education spending, by level (Rupees)	Data source: MoSPI (2019)
Out-of-pocket spending per student, by level (in Rs.)	pre_primary + primary + upper_primary_middle + secondary + higher_secondary + post_higher_secondary
Number of public-school students, by level	By level: out_of_pocket_spending_per_student * number_of_students
Number of private-aided school students, by level	NSO (2019)
Number of private-unaided school students, by level	By level: number_of_students * %_of_students_attending_public_school
% of students attending public, private aided, private unaided school	By level: number_of_students * %_of_students_attending_private_aided_school
Total number of students, by level	By level: number_of_students - number_of_public_school_students - number_of_private_aided_school_students
Population of corresponding age group	NSO (2019)
Gross enrollment rate, by level (as %)	gross_enrollment * population_of_corresponding_age_group
<i>w</i>	UN (2019)
	NSO (2019)
	Level of teacher wages (as ratio of GDP per capita) that satisfies
	$E = \frac{w}{STR} e^{\frac{SAP}{100 - E^{oth}}}$

Appendix 3. Water and Sanitation

The percentage of served population in rural and urban areas and the cost per capita of providing the service was obtained from different sources and updated data, when available, were provided by government authorities. Table A3.1 reports the reviewed statistics of coverage by type of water and sanitation service. The target population unserved in 2030 was extrapolated from the percentage of rural and urban population unserved in 2019, the additional population growth between 2019 and 2030, and the migration from rural to urban areas. This implies, *ceteris paribus*, an improvement in the coverage ratios by simple migration from unserved rural to served urban areas.

Table A3.1. India: Statistics of Coverage by Type of Water and Sanitation Service

	Rural		Urban	
	Coverage (percent)	Cost per capita (US\$)	Coverage (percent)	Cost per capita (US\$)
End open defecation ^a	100.0	—	100.0	—
Basic water ^b	89.5	15.4	100.0	55.6
Basic sanitation ^c	97.4	37.4	98.5	145.0
Basic hygiene ^d	70.7	21.6	84.8	8.0
Safely managed water ^e	56.1	36.1	81.1	249.6
Safely managed sanitation ^f	61.1	168.5	35.1	122.3

Source: IMF staff calculations using data from UN, World Bank, Ministry of Drinking Water & Sanitation, NSO 76th Round July-Dec 2018, Ministry of Housing & Urban Affairs, and interviews with NITI Aayog officials.

Notes: Statistics used for the computation of the SDG additional spending in water and sanitation.

(a) Ending open defecation refers to access to services that remove the need for open defecation—improved or unimproved toilet facility (e.g., pit latrines without a slab/platform, hanging latrines, bucket latrines). NITI Aayog considers 100 percent coverage based on the provision of 114 million latrines.

(b) Basic water service is the access to an improved water source within 30 minutes roundtrip. NITI Aayog considers access to a river, stream, or pond as “basic water.”

(c) Basic sanitation service is the access to improved sanitation facilities such as flush toilets or latrine with a slab on household premises.

(d) Basic hygiene service refers to the presence of handwashing stations in the household with soap and water. The actual practice of hand washing after defecation (with soap and water) is lower: 66.8 percent of rural population and 88.3 percent of urban population.

(e) Safely managed water service is the access to improved water source on household premises. According to NITI Aayog, 72.5 million urban population are envisaged to be provided with safely managed water by the Government of India.

(f) Safely managed sanitation service is the access to improved sanitation facility on household premises where excreta are safely disposed of in situ or treated off-site. According to the Ministry of Drinking Water & Sanitation, there is no drainage (no formal system of carrying off household wastewater and liquid waste) reported for 38.9 percent of rural population and 8 percent of urban population. According the Ministry of Housing and Urban Affairs and NITI Aayog, there are 133.5 million people not covered in small towns (below class 1) and 106.9 million people not covered in Class 1 cities.

As the goal in water and sanitation is full coverage in each service category (i.e., basic water, sanitation, and hygiene, safely managed water, and sanitation provision), the cost per type of service and population strata was computed as the product of the population unserved times the cost per capita of providing the service by type of service and population strata.

To avoid double counting and since the services are incremental (i.e., populations with safely managed sanitation have access to more basic services like water and latrines), we compute the total population unserved as the maximum of rural population unserved by type of service plus the maximum of urban population unserved by type of service. Following the WASH methodology developed by the World Bank (Hutton and Varughese, 2016), the total cost was calculated as the full cost of providing safely managed water and sanitation services plus half of the cost of providing the basic water and sanitation.

Appendix 4. Roads

The cost per kilometer (km) by type of road—highway, local, and rural—is taken from the Government of India, Ministry of Road Transport and Highways' (2018b) normative costs. The average cost of road construction was estimated at US\$ 509 thousands per kilometer. This assumes that future roads are going to follow the same proportion as currently observed between share of highways, local (district, urban, and project) roads, and rural roads as a percent of total roads from the Government of India, Ministry of Road Transport and Highways (2019). Table A4.1 provides the input data used for the estimation of the average cost per km of road.

Table A4.1. India: Cost of Road Construction

Type	Share of Roads (percent)	Cost per km (INR cr.)	Cost per km (US\$)	Reference
National and state highways	4.91	10.87	1,509,722	Greenfield alignment 8-lane, 1.5m
District, urban, and project roads	24.44	4.26	591,667	Greenfield alignment 2-lane, 1.5m
Rural roads (including JRY)	70.65	2.96	411,111	Service road with flexible pavement (10m carriageway)
Weighted average			509,181	

Source: IMF staff calculations based on data from the Government of India, Ministry of Road Transport and Highways (2018b).

Note: We converted these costs to US\$ at a rate of 72 INR/US\$.

The goal in roads for EMEs is to increase the Rural Access Index (RAI, i.e., the share of the population that has access to a road within two kilometers) to at least 90 percent by 2030. Keeping roads constant, the migration from rural to urban areas—assuming a general migration pattern from not connected rural areas to connected rural areas and urban areas—mechanically increases the RAI. We account for population migration to calculate the migration-adjusted RAI in 2030 using the following equation:

$$RAI_{2030}^{migration-adjusted} = 1 - \frac{\overbrace{Rural_{2019} \times (1 - RAI_{2019}^{observed})}^{current\ rural\ population\ not\ connected} - \overbrace{(Rural_{2019} - Rural_{2030})}^{migration\ from\ rural\ to\ urban}}{Rural_{2030}}$$

migration-adjusted rural population without access to roads

where *Rural* is the actual share of rural population in 2019 and projected share of rural population in 2030. Consequently, India's RAI in 2019 increases from 70 to 77 when adjusted for migration dynamics.

We estimate the additional road density needed to increase in the RAI from its current level in India to at least 90 percent by 2030 by estimating the following ordinary least squares regression specification:

$$lg_cia_density = \alpha + \beta_1 \times lggdp_cap + \beta_2 \times lgpop_density + \beta_3 \times RAI + \beta_4 \times agg_gdp + \beta_5 \times manu_gdp + \beta_6 \times urban + \varepsilon$$

where *lg_cia_density*, *lggdp_cap*, and *lgpop_density* are the natural logarithms of road density, GDP per capita, and population density, respectively, RAI is the rural access index, *agg_gdp* is the aggregated GDP, *manu_gdp* is the ratio of manufacturing to GDP, *urban* is the share of the urban population in total population, α is a constant, and ε is the error term. The regression is restricted

to low-income and developing economies, and emerging market economies with medium-range road density (i.e., for comparability it does not incorporate advanced economies, or countries with too low or too high road density). This approach assumes away contemporaneous reverse causality: i.e., road density affects income per capita and population density with a substantial lag (Fay and Yepes, 2003).

The additional road length needed to meet the SDG goal is estimated at 2.4 million kilometers. Finally, the total cost of the additional road network is computed by multiplying the additional kilometers by the unit cost of constructing one kilometer at US\$ 509,181 (Table A4.1) and accounting for a 5 percent annual depreciation rate.

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