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Will economic growth be sufficient to end global poverty? New projections of the UN Sustainable Development Goals

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WIDER Working Paper 2023/123

Will economic growth be sufficient to end global poverty?

New projections of the UN Sustainable Development Goals

Arief A. Yusuf,¹ Zuzy Anna,¹ Ahmad Komarulzaman,¹
and Andy Sumner²

October 2023

Abstract: In this paper, we present new projections for a range of global poverty-related Sustainable Development Goals (SDGs), specifically, extreme monetary poverty, undernutrition, stunting, child mortality, maternal mortality, and access to clean water and basic sanitation. Our projections, based on economic growth forecasts, take into account recent global shocks such as the COVID-19 pandemic and the inflation shock. Our findings indicate that economic growth alone will not be sufficient to end global poverty, and the global poverty-related SDGs will not be met by a considerable distance. The implication of this, we argue, is that a stronger focus is needed on inclusive growth (SDG-8), and specifically redistribution with growth at global and national levels. This would mean more emphasis on policies to build productive capacities, and the introduction or expansion of income transfers as well as ensuring public investments are sufficient to meet the SDGs. To this end new international financing needs to be made available through debt relief or other forms of finance to expand developing countries' fiscal space.

Key words: poverty, growth, nutrition, health, inequality, SDGs

JEL classification: D6, I3

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1 Introduction

In this paper, we present new projections across a set of global poverty-related Sustainable Development Goals (SDGs), specifically extreme monetary poverty, undernutrition, stunting, child mortality, maternal mortality, and access to clean water and basic sanitation. Our findings indicate that economic growth alone will not be sufficient to end global poverty and the global poverty-related SDGs will not be met by a considerable distance. In fact, our projections point towards the potential for a new ‘lost decade’ for countries of the Global South, somewhat resonating with the experience of the 1980s, unless action is taken.¹ The implication of this, we argue, is that new focus is needed on inclusive growth (SDG-8), and specifically redistribution with growth at global and national levels. This would mean more emphasis on policies to build productive capacities, and the introduction or expansion of income transfers as well as ensuring public investments are sufficient to meet the SDGs.

Existing studies of SDG projections post-pandemic are sparse. The most recent existing studies regarding a range of global poverty-related SDG projections were published in 2021 during the pandemic (e.g., Hughes et al. 2021; Sörgel et al. 2021). These are discussed in depth in the UN (2023) ‘Global SDG Report 2023’. The authors are not aware of any post-pandemic empirical projections seeking to make estimates for a wide range of global poverty-related SDGs to 2030. There are two post-pandemic projections of individual SDGs. First, the World Bank (2023) projects extreme poverty based on World Bank (June 2022) Global Economic Prospects’ growth forecasts to be 574 million in 2030 or 7% of the global population.² Moreover, the pandemic has pushed an additional 71 million people into extreme poverty beyond the crisis (temporary poverty in 2020–21 might have been even higher). Second, there is a projection of undernutrition by the FAO, IFAD, UNICEF, WFP, and WHO (2023: 17) using a computable general equilibrium (CGE) model that forecasts 590 million undernourished people in 2030, approximately 120 million more than pre-COVID projections. How do our new global estimates compare? We, too, project that the world in 2030 will not achieve these SDGs. In fact, our projections for extreme poverty and undernutrition based on the April 2023 World Economic Outlook (WEO) growth forecasts by the International Monetary Fund (IMF) are slightly more pessimistic than these cited studies. Overall, our findings indicate that none of the seven global poverty-related SDGs we assess will be met, and by a considerable distance. In short, economic growth will not be sufficient to meet the global poverty-related SDGs.

The structure of this paper is as follows. Section 2 presents an overview of the methodology (with further details in the annex). Section 3 presents the global and regional results. Section 4 discusses how the composition of global poverty will change by 2030. Section 5 concludes.

2 Methodology

Our approach to making projection is grounded in the assumption that a set of global poverty-related SDGs indicators are closely linked to income per capita. This assumption holds true for

¹ The 1980s have been referred to as the ‘lost decade’ for development, during which many countries in the Global South experienced weak or no improvement in poverty indicators.

² The World Bank’s definition of ‘meeting’ the goal equates to a poverty rate below 3%, which translates to 255 million people in 2030. As Ravallion (2020: 1) notes, there is a ‘little-noticed’ difference between the World Bank’s goal of reducing poverty to under 3% (itself based on Ravallion 2013) and the UN SDG goal of ‘eradicating’ poverty by 2030.

the indicators we chose. Thus, we can utilize economic growth forecasts regularly reported by the IMF in the WEO for such projections. We can take advantage of the April 2023 IMF growth forecasts that take into account the recent shocks of COVID-19 and the inflation shock.

At the core of our approach lies the empirical relationships between income per capita and SDGs indicators in the historical data, in short, the elasticity of SDGs indicators concerning income per capita. First, we identify which SDG indicators are sufficiently associated with income per capita. To achieve this, we employ a protocol developed by Komarulzaman et al. (2022a, 2022b) to filter the vast number of SDG indicators available in the UNSTATS database. There are many SDG indicators in the database; and due to the various dimensions (gender, location, age groups, income class, etc.), these indicators combine to create as many as 4,998 unique indicators. We identify a smaller subset of these nearly 5,000 indicator-dimensions that exhibit (i) a strong correlation with economic growth and (ii) relate to global poverty.

Our protocol involves conducting cross-country linear and non-linear regressions for all 4,998 SDG indicators in the UNSTATS database, associating them with income per capita. The steps, as illustrated in Figure 1 (the protocol) and explained in more detail in the appendix, encompass data cleaning, estimating linear regression for all indicators (with various dimensions), and based on these results, retaining only those with sufficiently good R-squared values, theoretically consistent and statistically significant relationships with income per capita. Recognizing the non-linearity of the relationship, we re-estimate the relationship with different specifications (both linear and non-linear) and choose among those specifications the one with the lowest root-mean-square error (RMSE) to assess the difference between true and predicted values (see Table A1).

From this refined selection of indicators, we estimate the country-specific elasticity of each SDG indicator with respect to income per capita (and hence economic growth). Ultimately, we select seven global poverty-related SDG indicators out of approximately 317 indicators that have passed through the protocol. These indicators include extreme poverty, undernourishment, stunting, under-five mortality ratio, maternal mortality ratio, access to safe drinking water, and access to basic sanitation.

Our dataset covers a substantial portion of the population in developing countries, with 70% of the population in developing countries having correlated income per capita and each specific poverty-related SDG indicator. We employ various methods to deal with missing data: (i) when income per capita data are available, and SDG indicators exist for some years, we use the elasticity approach to impute missing data; (ii) in cases where income per capita data are not available, we impute missing values based on the mean income level of the relevant regional group; (iii) in a few instances, missing data are imputed solely using the mean income level of the country's income group, as calculating the mean for a combination of region and income level is not feasible due to insufficient observations.

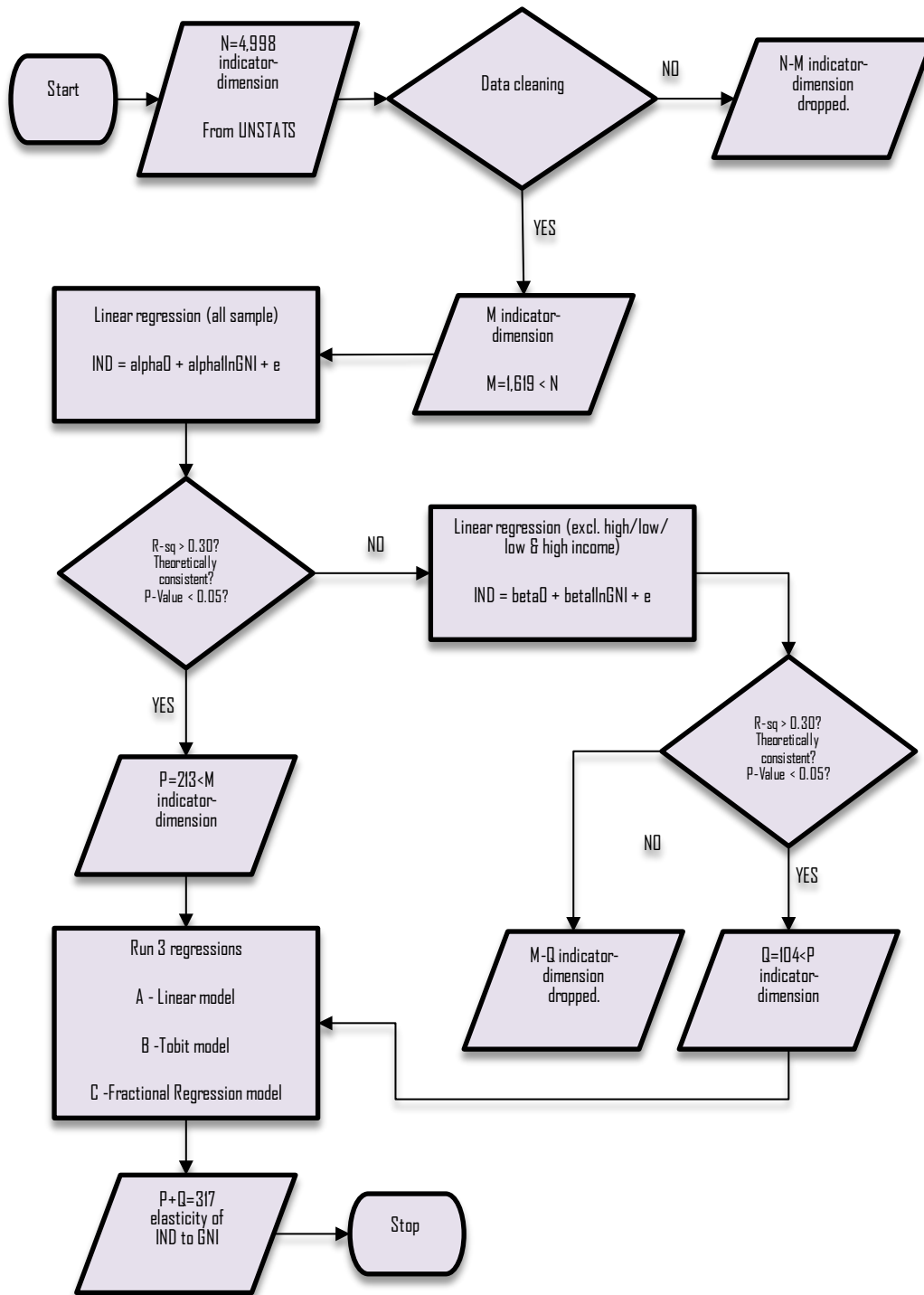
Figure 1 shows the protocol we utilize, while Figure 2 displays our set of poverty-related SDGs and linear and non-linear lines of best fit. A methodological annex provides further details. We find that for our set of seven indicators, which represent a pure cross-sectional relationship (not a time series), the correlation (R-squared of the linear model) is good. It is important to note that the linear model is used *solely* to determine which indicators to include. The *actual* model employed is the non-linear model (best curve fitting), resulting in a better goodness of fit (though such models do not produce a standard R-squared to report).

Several limitations of our methodology should be noted. First, any growth forecasts are—inevitably—open to challenge. Which growth forecast to use for the purpose of projecting the poverty-related SDGs is not a simple question. As we note above, we use the IMF's World

Economic Outlook (WEO) growth forecasts in our estimates in this paper, as the World Bank's growth forecasts published in the Global Economic Prospects (GEP) forecast only two years ahead of the current year (so June 2023 has forecasts for growth in the current year, 2023, and then 2024 and 2025) and have limitations on country coverage (GEP covers 126 countries compared to WEO which covers 189 countries). However, one limitation of the IMF's growth forecasts versus the World Bank growth forecasts is that the former are not derived from a global model (and thus interdependencies). Instead, IMF growth forecasts are based on IMF country teams' desk estimates (see discussion of Sandefur and Subramanian 2020). Although the World Bank growth forecasts do come from a global model, the model is not publicly available (the GEP report has just a paragraph of detail), and there is still a subjective aspect in that the model generates forecasts that then are open to discussion and potentially adjustment by World Bank country teams (see World Bank 2023: 155). Considering the limitations of all forecasts, we use the IMF growth forecasts in this paper because their forecasts cover a longer time and many more countries.

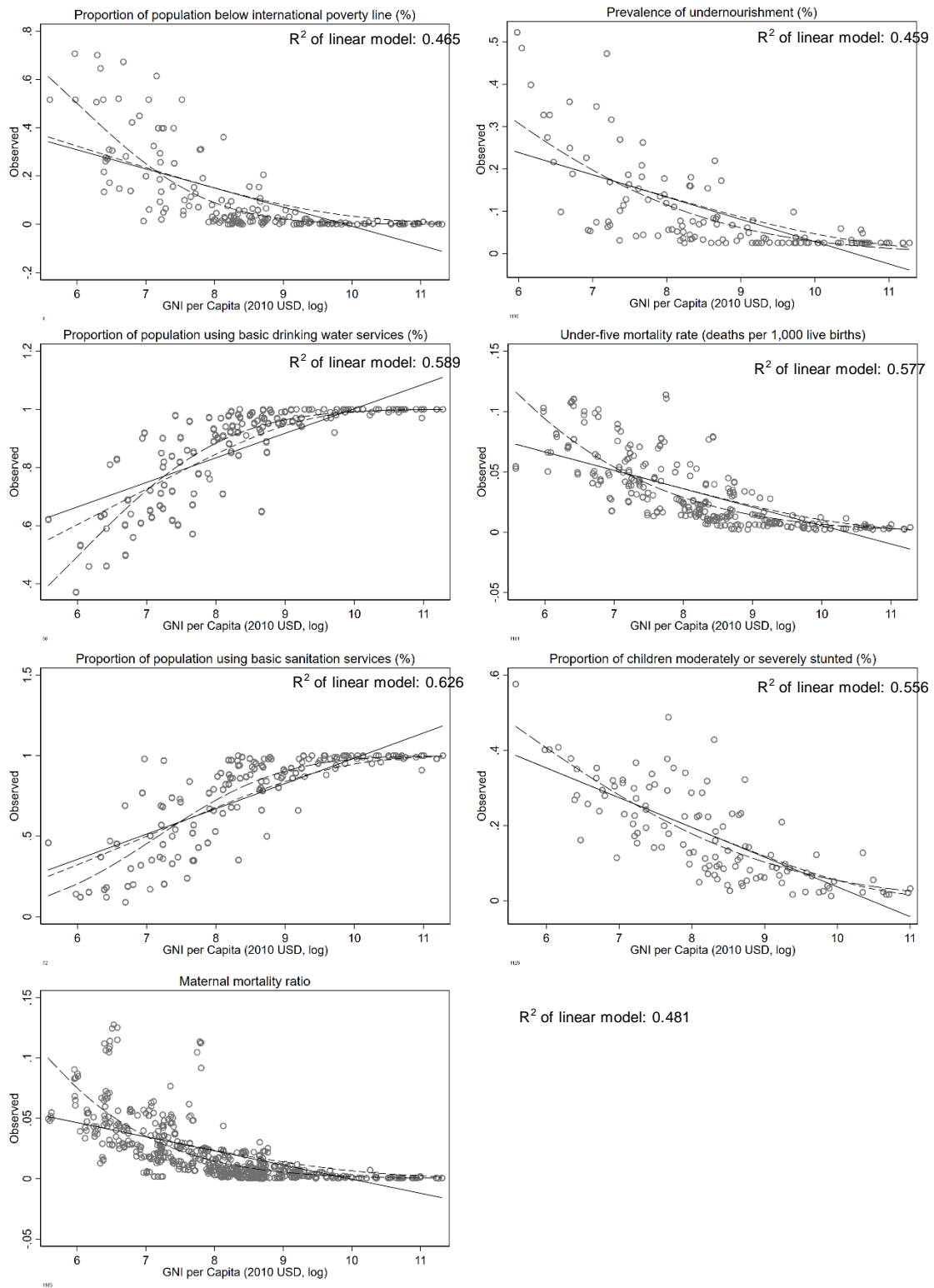
A second limitation is that many potentially poverty-related SDGs are filtered out due to a lack of association with income per capita or poor coverage of developing countries population. For example, the education SDGs (SDG-4) are not included in our projections, nor are gender inequality (SDG-5) or income inequality (SDG-10). Third, the chosen poverty-related SDG indicators cover approximately 70% of the population in all developing countries (as defined by the World Bank, encompassing low- and middle-income countries). Therefore, we impute missing data for countries. This means that if a large, populous country lacks data, it will be assumed to have the average for its respective region within that income group. It is plausible that this approach may underestimate the real level of poverty because countries without basic data are generally very poor. As such, our estimations may be considered conservative.

Figure 1: Protocol utilized



Source: authors' elaboration.

Figure 2: Global poverty-related SDGs and linear and non-linear lines of best fit



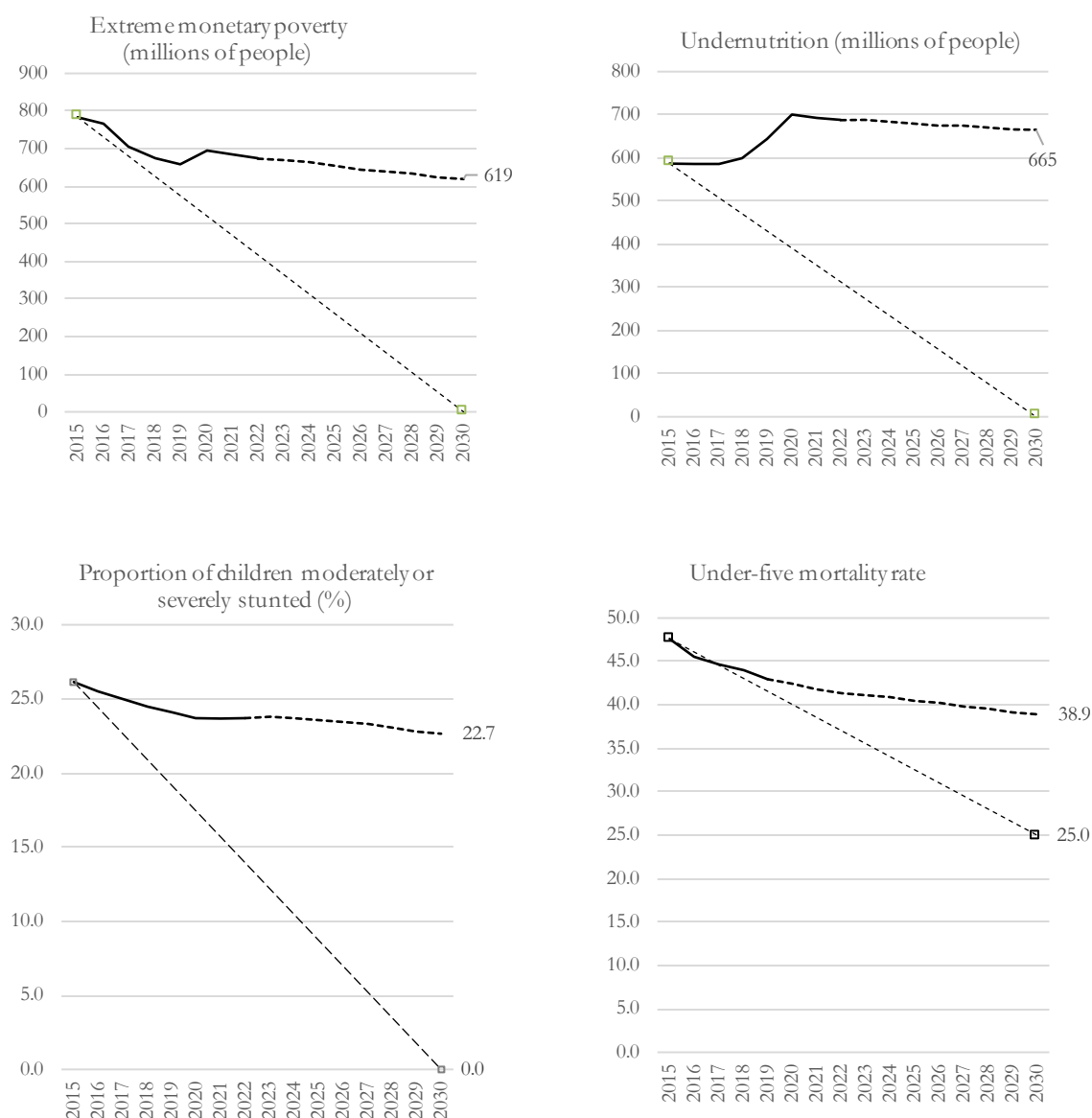
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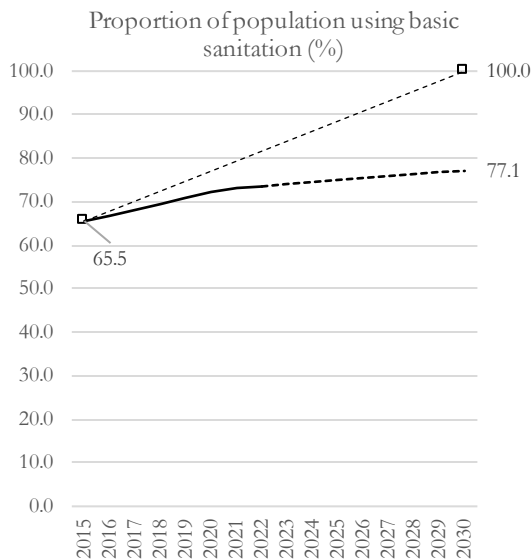
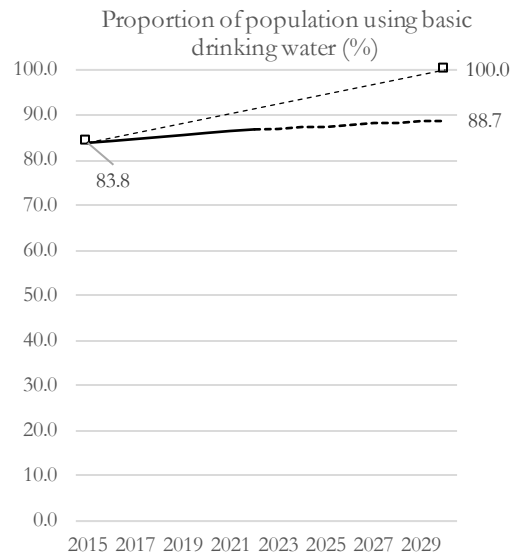
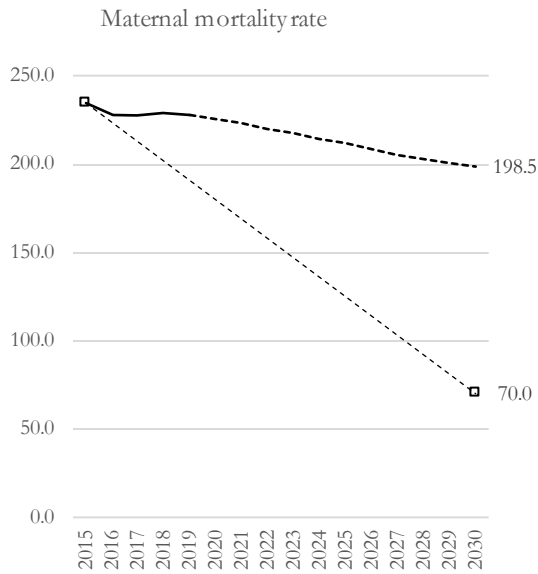
3 Projections

3.1 Global estimates

We find that in 2030 over 600 million people will remain in extreme monetary poverty and 665 million people will be undernourished. We concur with the FAO, IFAD, UNICEF, WFP, and WHO projections that the number of undernourished people will be higher than pre-COVID and, in fact, higher than in 2015 when the SDGs were agreed upon. We also project that more than one in five children will be stunted and, although under-five mortality and maternal mortality will improve, the progress will be slow. Access to safe water and basic sanitation will remain major challenges. The number of people lacking access to safe water will still be one in ten in 2030 (800 million people). The number of people lacking basic sanitation will be more than one in five of the population in developing countries in 2030 (1.7 billion people). Figure 3 plots the projections.

Figure 3: Projections of poverty-related SDGs, 2015–30





Note: projections are for developing countries and do not include high-income countries.

Source: authors' estimates.

3.2 Regional and country income group estimates

Next, we turn our attention to examining trends within each region and across countries grouped by income levels, revealing prospects depending on the specific indicator under consideration.

Regarding extreme monetary poverty, we project an increase in the numbers of people living in extreme poverty in sub-Saharan Africa (SSA) and low-income countries (LICs). Conversely, South Asia and middle-income countries (MICs) show a decline in those living in extreme poverty. In other regions, poverty numbers remain relatively low and exhibit some stability over time. This pattern is also reflected in our forecast for undernutrition, where SSA and LICs experience rising levels, while MICs and South Asia demonstrate declining trends. Elsewhere, undernutrition

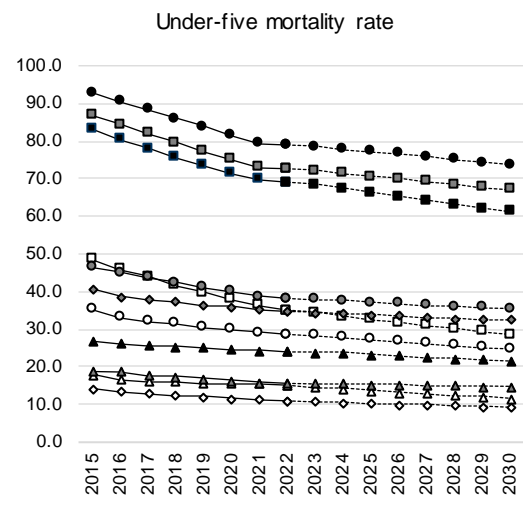
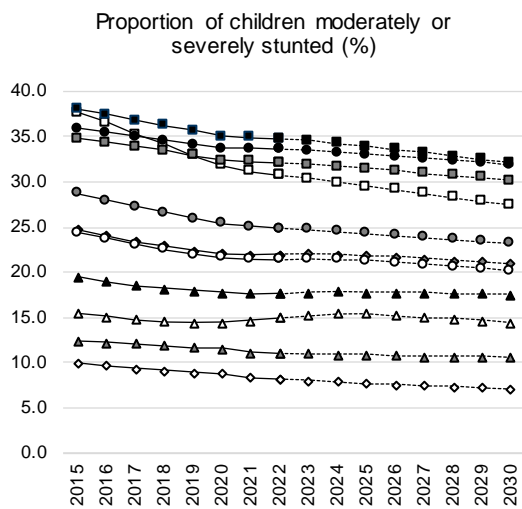
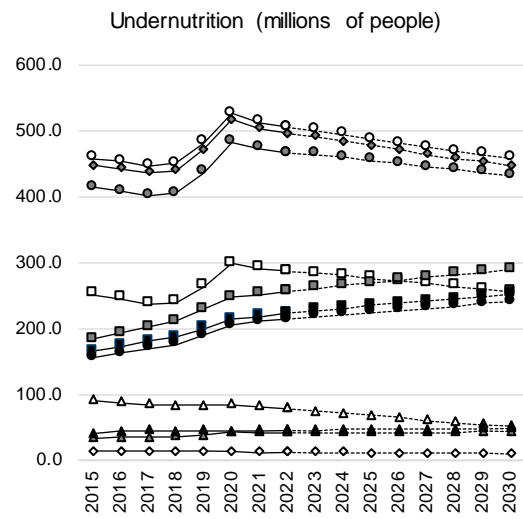
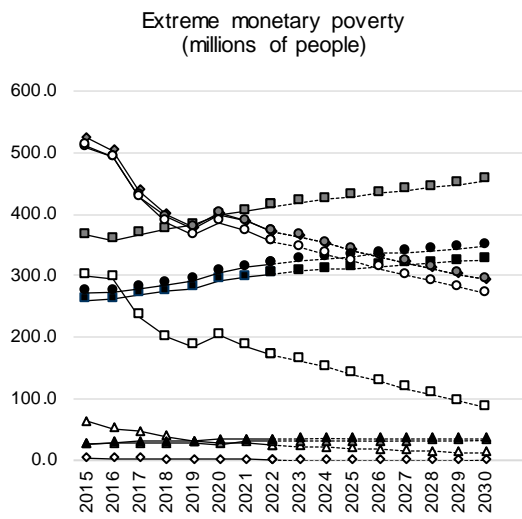
diminishes in East Asia and the Pacific and remains constant in other regions. Nevertheless, it is noteworthy that by 2030, most of the world's undernourished population will still reside in MICs, rather than LICs.

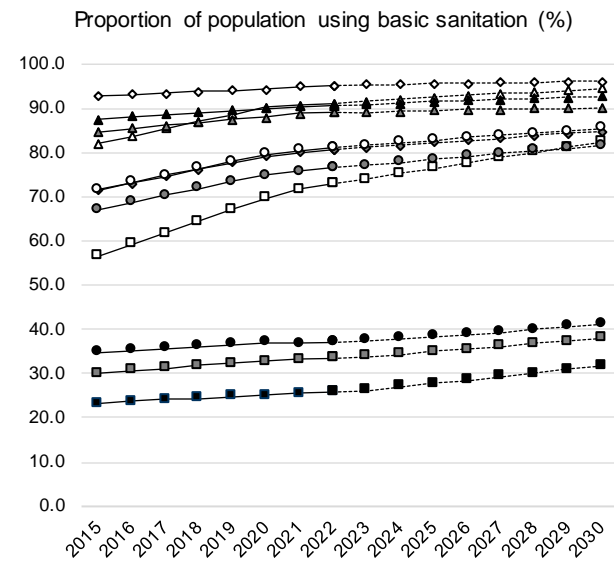
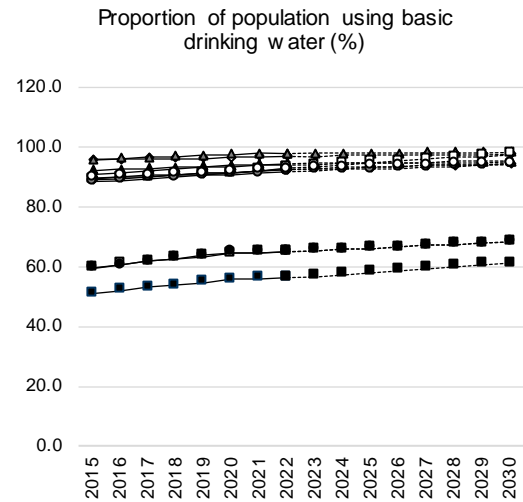
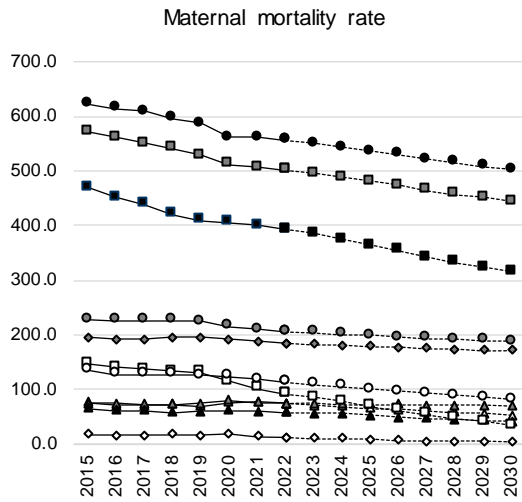
Turning to the issue of stunting, progress remains slow. In SSA and LICs, stunting rates persist at alarmingly high levels even in 2030, affecting about a third of the children. South Asia also reports high stunting rates, with more than a quarter of children experiencing this condition, while MICs have stunting rates above a fifth. Similarly, under-five mortality and maternal mortality rates exhibit slow improvements. In SSA and LICs, these rates, though gradually decreasing, remain exceptionally high. Meanwhile, MICs and South Asia report lower rates, but their progress is slowish towards 2030.

In terms of access to basic water and sanitation, progress is minimal. Even by 2030, around a third of the population in SSA and LICs are projected to still lack access to basic drinking water, and two thirds are projected to lack access to basic sanitation. In Figure 4, please note that the lowest trend line on the access to water graph is LICs (black squares), and above that are the FRG and SSA trend lines that sit on top of each other (and thus appear to show black squares).

In summary, our findings are as follows. First, extreme monetary poverty and undernutrition will rise in SSA and LICs and decline in South Asia and MICs. Although by 2030, most of the world's extreme poverty will be in LICs, most of the world's undernourished population will still be found in MICs. Second, stunting rates will remain high in SSA and LICs, even in 2030. Third, under-five mortality and maternal mortality rates will improve slowly. Fourth, progress in achieving access to basic water and sanitation will be also slow. Finally, in terms of country types, non-fragile and conflicted-affected situations (non-FCAS) countries currently exhibit higher numbers of extreme poverty and undernourishment. This will change for extreme poverty in that FCAS and non-FCAS shares will be similar in 2025. However, undernutrition displays a different pattern and will remain higher in non-FCAS. FCAS countries will experience much worse mortality rates and significantly lower access to water and sanitation.

Figure 4: Regional projections of poverty-related SDGs, 2015–30





▲ EAP ◇ ECA ▲ LAC ▲ MENA
 □ SA □ SSA ■ LIC ◇ MIC
 ● MIC' ● FRG ○ NFRG

Note: EAP—East Asia and Pacific, ECA—Europe and Central Asia, LAC—Latin America and Caribbean, MENA—Middle East and North Africa, SA—South Asia, SSA—sub-Saharan Africa, LIC—low-income countries, MIC—middle-income countries, MIC'—middle-income countries excluding China, FRG—fragile and conflict-affected situations, NFRG—non-fragile and conflict-affected situations. Projections are for developing countries and do not include high-income countries. Fragile and conflicted-affected situations (FCAS) based on World Bank 2023 list.

The lowest trend line on the access to water graph is LICs (black squares), and above that are the FRG and SSA trend lines that sit on top of each other (and thus appear to show black squares).

Source: authors' estimates.

4 Where will poverty be concentrated in 2030?

An important question to ask is where are the prospects for poverty reduction likely to be worse? One way of answering this question is to consider the distribution of poverty by each indicator in 2015 and in 2030 projections. What do we find? We can see that extreme monetary poverty will be dominated by SSA in 2030, although South Asia will still have a sizeable proportion. In contrast, undernutrition and stunting will continue to be split between SSA and South Asia, though the SSA share will expand. Under-five mortality and maternal mortality are already very concentrated in SSA, and this will expand further, especially for maternal mortality. Finally, for access to water and sanitation, we see the expanding shares for SSA, though sizeable proportions will remain in South Asia even in 2030.

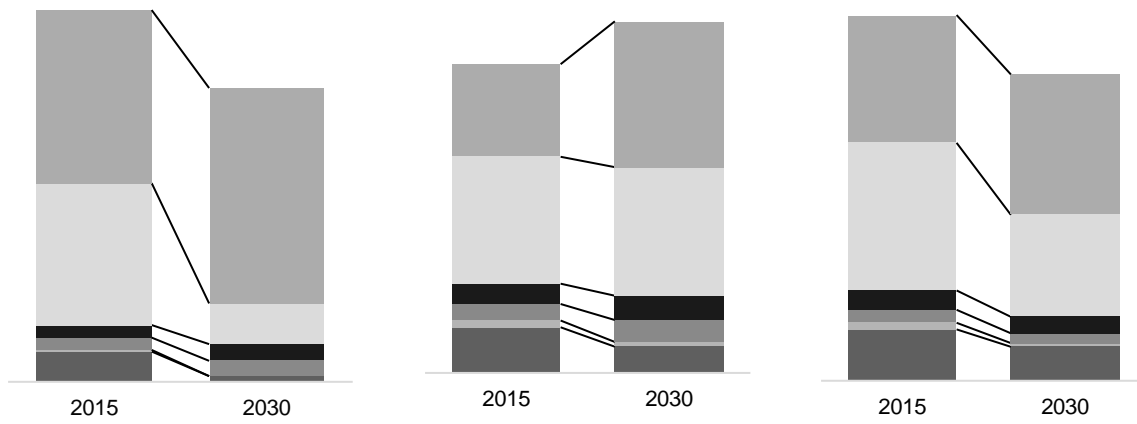
In sum, the prospects for extreme monetary poverty reduction are weakest in SSA, as this region will dominate counts of extreme poverty in 2030 (although South Asia will still have a notable proportion). Undernutrition and stunting will continue to be split between SSA and South Asia in 2030 (though the SSA share will expand). Under-five mortality and maternal mortality are already very concentrated in SSA, and this will expand further by 2030. In access to water and sanitation, there is an expanding share for SSA, though notable proportions will remain in South Asia and elsewhere. Finally, in general there is an expansion of shares of poverty in fragile/conflict countries, both LIC FCAS and MIC FCAS, and although the share of non-FCAS MICs is shrinking, there is a surprisingly significant proportion even in 2030.

Figure 5a: Regional distribution of poverty-related SDGs

Extreme poverty (number of people who live < PPP\$2.15 a day)

Number of people who are undernourished

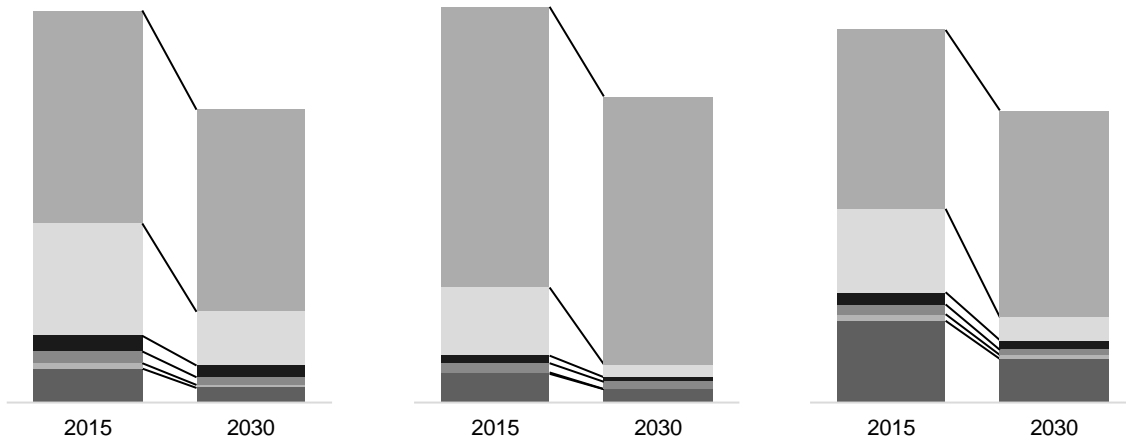
Number of children who are stunted



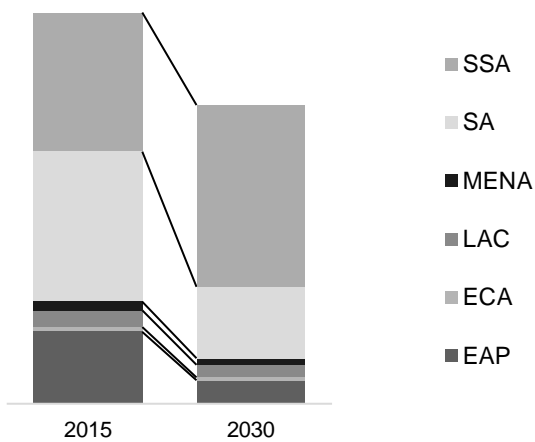
Under-five mortality

Maternal mortality

People without access to safe drinking water



People without access to sanitation



Note: EAP—East Asia and Pacific; ECA—Europe and Central Asia; LAC—Latin America and Caribbean; MENA—Middle East and North Africa; SA—South Asia; SSA—sub-Saharan Africa.

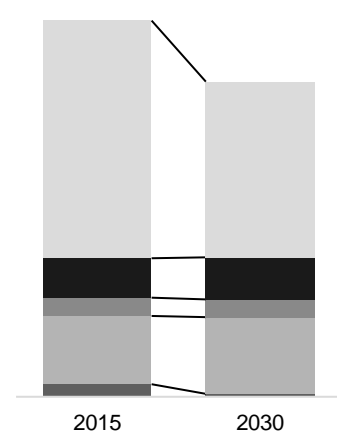
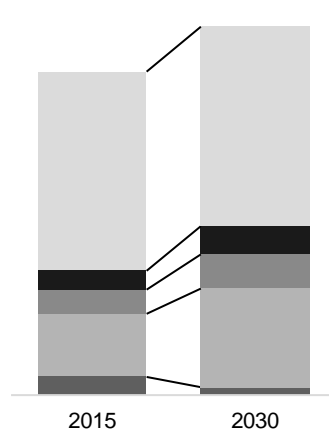
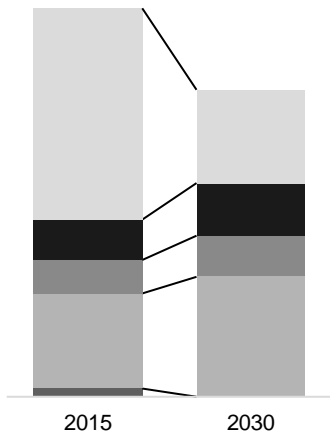
Source: authors' estimates.

Figure 5b: Income group distribution of poverty-related SDGs

Extreme poverty (number of people who live < PPP\$2.15 a day)

Number of people who are undernourished

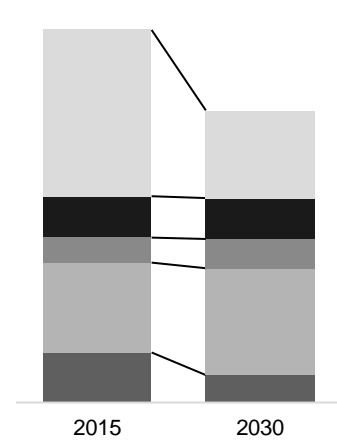
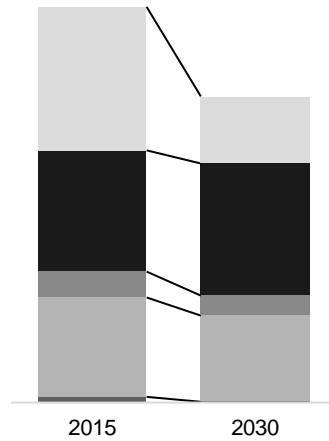
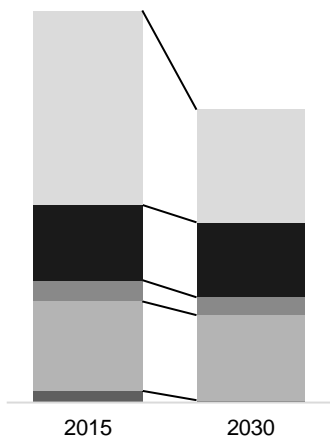
Number of children who are stunted



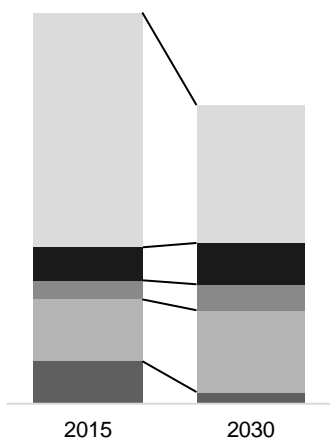
Under-five mortality

Maternal mortality

People without access to safe drinking water



People without access to sanitation



- MICNFR
- MICFR
- LICNFR
- LICFRG
- CHN

Note: MICNFR—middle-income non fragile states; MICFR—middle-income fragile states; LICFRG—low-income fragile states; LICNFR—low-income non fragile states; CHN—China.

Source: authors' estimates.

5 Conclusions

Our projections point towards three conclusions. First, the global poverty-related SDGs will not be met and by a considerable distance. Second, the weak outlook for economic growth implies that a stronger focus is needed on inclusive growth (SDG-8), and specifically redistribution with growth at global and national levels, as well as a stronger emphasis on building productive capacities. This agenda on global and national redistribution is akin to Chenery et al.'s (1974) call for 'Redistribution with Growth' that advocated for asset redistribution, income transfers, and public investments with a focus on productive capacity and raising the incomes of the poor. Crucially, this requires the deliberate adoption of the twin objectives of both redistribution and growth. This has the potential to be applied at the global level as well as national level. Third, it is becoming evident that debt relief and other forms of development finance will be needed in the coming years to ensure scope for social and productive spending to expand—not contract—in the Global South.

References

- Chenery, H., M.S. Ahluwalia, C.L.G. Bell, J.H. Duloy, and R. Jolly (1974). *Redistribution With Growth*. Oxford: Oxford University Press.
- FAO, IFAD, UNICEF, WFP, and WHO (2023). *The State of Food Security and Nutrition in the World 2023. Urbanization, Agrifood Systems Transformation and Healthy Diets across the Rural–Urban Continuum*. Rome: FAO. <https://doi.org/10.4060/cc3017en>
- Gable, S.E., H. Lofgren, and I. Osorio-Rodarte (2015). *Trajectories for Sustainable Development Goals: Framework and Country Applications*. Washington, DC: World Bank Group.
- Hughes, B.B., T. Hanna, K. McNeil, D.K. Bohl, and J.D. Moyer (2021). *Pursuing the Sustainable Development Goals in a World Reshaped by COVID-19*. Denver and New York: Frederick S. Pardee Center for International Futures and United Nations Development Programme.
- Komarulzaman, A., Z. Anna, A.A. Yusuf, and V. Anbumozhi (2022a). 'The Impact of Global COVID-19 Crisis on SDGs Achievement in ASEAN-Countries'. In V. Anbumozhi, K. Kalirajan, and F. Kimura (eds), *Sustainable Development Goals and Pandemic Planning* (pp. 27–113). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-16-6734-3_2
- Komarulzaman, A., Z. Anna, A.A. Yusuf, and V. Anbumozhi (2022b). 'Multi-Country SDGs Indicator Projections Involving Impacts of Economic Shocks: A Protocol Applied To the COVID-19 Pandemic for ASEAN-5 Countries'. *MethodsX*, 9: 1–11. <https://doi.org/10.1016/j.mex.2022.101772>
- Ravallion, M. (2020). 'SDG1: The Last Three Percent'. CGD Working Paper 527. Washington, DC: Center for Global Development
- Sandefur, J., and A. Subramanian (2020). 'The IMF's Growth Forecasts for Poor Countries Don't Match Its COVID Narrative'. CGD Working Paper 533. Washington, DC: Center for Global Development
- Sörgel, B., E. Kriegler, I. Weindl et al. (2021). 'A Sustainable Development Pathway for Climate Action within the UN 2030 Agenda'. *Nature Climate Change*, 11: 656–64. <https://doi.org/10.1038/s41558-021-01098-3>
- UN (2023). *Global SDG Report 2023* (Advanced Unedited Version, 14 June 2023). New York: United Nations.
- World Bank (2022). *Poverty and Shared Prosperity 2022*. Washington, DC: World Bank.
- World Bank (2023) *Atlas of SDGs 2023*. Washington, DC: World Bank.
- World Bank (2023) *Global Economic Prospects*. Washington, DC: World Bank.

Appendix

A Selection of SDGs indicators that have a close association with income per capita

As illustrated in Figure 1 (in the paper text), the steps to select SDG indicators that have a close association with income per capita are implemented through the following steps:

- i. We obtained the data of the indicators of the SDGs from the UNSTATS database, which was downloaded on 30 March 2023. We then organized this data according to the 17 SDGs, comprising 229 indicators and 569 series, each having multiple dimensions like gender, age, education level, or geographical location). This diverse combination resulted in the initial identification of a total of 4,998 unique indicator-series-dimension combinations.
- ii. We collected income (gross national income [GNI]) per capita data from the World Development Indicators (WDI) of the World Bank and merged this with the SDG indicators from UNSTATS database.
- iii. Data cleaning: We dropped indicators that contained only category (not continuous) or with only two unique values, or difficult to interpret in terms of improvement, or with limited number of countries available (less than four countries). After this data cleaning, we retained 1,619 unique indicator-dimensions.
- iv. For each country, we used the most recent data of pairs of SDG indicators and GNI per capita from 2013 to 2021.
- v. We ran a linear regression of $E(y|GNI) = \alpha_0 + \alpha_1 GNI$ for each of the 1,619 unique indicator-dimensions. From each regression we collect its results on R-squared, its coefficient of the variable GNI, and the P-value of the coefficient. When the coefficient had the expected sign, statistically significant (has P-value < 0.05), and the regressions produced R-squared more than 0.30 (see Gable et al., 2015), we considered the indicator had a sufficient association with income per capita and would be retained in the analysis. Up to this step, we had retained only 213 unique SDGs indicator-dimension from 1,619.
- vi. The relation between SDG indicator and income per capita may exhibit non-linearity. For instance, near universal drinking water and sanitation coverage can be achieved even before a country reaches a very high-income status. Consequently, when plotting the connection between GNI per capita and access to drinking water and sanitation, we may observe a positive slope in the low- and middle-income categories, followed by flatter curves in the high-income category. To address this challenge, one potential solution was to exclude high-income countries from the analysis. This approach was then employed to re-evaluate the validity of the relationship for the indicator-series-dimension that did not meet the criteria in the previous selection process. Comparable selection criteria were subsequently applied to advance to the next phase of the analysis. We therefore re-ran the regression three more times for each indicator (1) excluding high income, (2) excluding low income, (2) excluding high and low income. When any of these three pass the three tests (theoretical consistency, statistical significance, and goodness of fit), we then included them as indicators that had sufficient association with income per capita. These steps led to a selection of an extra 104 indicators dimensions. Combined with those that passed the filter at initial steps, we had as many as 317 SDG indicator-dimensions.

- vii. For each of the 317 SDGs indicator-dimensions, we ran three different regressions (including accommodating a non-linear relationship), i.e. linear model, Tobit model, and Fractional regression model. We chose the model that has the lowest root-mean-square error (RMSE) of the three models. These selected models were used to estimate the SDG indicator elasticity with respect to income per capita for the purpose of the projection. The scatter plots of the relationship of different models can be seen in Figure 2 (in the paper text) and the results of the regressions (for the seven poverty-related SDGs that we finally chose) can be seen in Table A1 below.

B Selection of seven poverty-related SDGs

As the focus of this paper is on poverty, we chose indicators that are related to poverty both from monetary and non-monetary dimensions. We also chose the indicators where the previous analysis (of filtering) includes countries that cover of at least 70% of the population of developing countries. The exception is extreme monetary poverty which covers 63% of the population of developing countries but is included due to that fact it is often highlighted as the SDG goal for ending poverty. So, we selected the following indicators:

1. Proportion of population below international poverty line, PPP\$2.15 per person per day (%);
2. Prevalence of undernourishment (%);
3. Proportion of children moderately or severely stunted (%);
4. Maternal mortality ratio;
5. Under-five mortality rate, by sex (deaths per 1,000 live births);
6. Proportion of population using basic drinking water services (%);
7. Proportion of population using basic sanitation services (%).

C Estimating SDG indicators elasticity with respect to income per capita

We estimated the elasticity of SDG indicators with respect to income per capita each year. In cases where the best (lowest RMSE) model is not linear, these elasticities are income per capita specific, so the elasticity will take a different value for each country and each year, making them country-time specific. We did this by calculating the marginal effect from the regression for each country and each year from 2015 to 2030.

D Projection of SDG indicator based on April 2023 IMF World Economic Outlook Database

We downloaded the projection of economic growth from April 2023 IMF World Economic Outlook Database, including the population projection. We assumed that the growth of GNI would be the same as the growth of GDP (we implicitly assumed that the proportion of net factor

payment from abroad would not change much till 2030 for each country). We combined the GNI growth with population growth to project the future trajectory GNI per capita toward 2030. Using the country-year specific elasticity, we calculated the trajectory of each country's SDG indicator toward 2030.

E Aggregation and imputation of missing data

To aggregate indicators at regional groups, income group, or event at global level, we first needed to impute missing data. For each missing data point, we used one of the following (and the Excel spreadsheet that contains information on each of these imputations is available upon request):

- i. When the SDGs indicator was not missing for at least one year, and the country has complete data for its GNI per capita, we used the elasticity approach to impute the missing data.
- ii. When a country does not have both the SDGs indicator and GNI per capita data, we imputed the mean of the indicator based on the income level and region to which the country belongs.
- iii. In some cases, a combination of region and income level contain no observations. In this case, we imputed the means of the income level to which the country belongs.

The aggregation (and mean imputation) was carried using a different weight for each of the seven indicators. For extreme poverty, undernourishment, access to water, and access to sanitation, we used population as the weight. For stunting, we used population under five years of age (data from UN Population Statistics) as the weight. For under-five mortality and maternal mortality, we used number of live birth (data from UN Population Statistics) as the weights.

F SDG targets for 2030

Our projections will be compared to the SDGs target as stated by the UN as follows:

1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day (later was updated to PPP\$2.15 a day). This implies zero extreme poverty in 2030.

2.1 By 2030, end hunger and ensure access by all people, the poor and people in vulnerable situations, including infants, to safe, nutritious, and sufficient food all year round. This implies zero undernourishment in 2030.

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons.

3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births.

3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.

1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance. This implies universal access (100%) target in 2030.

Table A1: Regressions results for the seven global poverty-related SDG indicators

| Code | Indicator | Model | Beta | P value beta | Constant | P value constant | R² | RMSE |
|-------------|--|--------------|-------------|---------------------|-----------------|-------------------------|----------------------|-------------|
| 1.1.1 | Proportion of population below international poverty line (%) | Linear | -0.079 | 0.000 | 0.784 | 0.000 | 0.461 | 0.120 |
| | | Tobit | -0.090 | 0.000 | 0.866 | 0.000 | | 0.117 |
| | | Frac-Reg* | -0.673 | 0.000 | 4.038 | 0.000 | | 0.100 |
| 1.4.1 | Proportion of population using basic drinking water services (%) | Linear | 0.084 | 0.000 | 0.158 | 0.002 | 0.600 | 0.094 |
| | | Tobit | 0.123 | 0.000 | -0.132 | 0.048 | | 0.081 |
| | | Frac-Reg* | 0.604 | 0.000 | -3.638 | 0.000 | | 0.078 |
| 1.4.1 | Proportion of population using basic sanitation services (%) | Linear | 0.157 | 0.000 | -0.586 | 0.000 | 0.618 | 0.166 |
| | | Tobit | 0.180 | 0.000 | -0.759 | 0.000 | | 0.155 |
| | | Frac-Reg* | 0.710 | 0.000 | -5.089 | 0.000 | | 0.144 |
| 2.1.1 | Prevalence of undernourishment (%) | Linear | -0.053 | 0.000 | 0.554 | 0.000 | 0.472 | 0.077 |
| | | Tobit | -0.053 | 0.000 | 0.554 | 0.000 | | 0.075 |
| | | Frac-Reg* | -0.348 | 0.000 | 1.587 | 0.000 | | 0.067 |
| 2.2.1 | Proportion of children moderately or severely stunted (%) | Linear | -0.079 | 0.000 | 0.828 | 0.000 | 0.572 | 0.081 |
| | | Tobit | -0.079 | 0.000 | 0.828 | 0.000 | | 0.080 |
| | | Frac-Reg* | -0.344 | 0.000 | 1.826 | 0.000 | | 0.079 |
| 3.1.1 | Maternal mortality ratio (death per 100,000 live births) | Linear | -0.012 | 0.000 | 0.117 | 0.000 | 0.485 | 0.017 |
| | | Tobit | -0.012 | 0.000 | 0.117 | 0.000 | | 0.017 |
| | | Frac-Reg* | -0.371 | 0.000 | 0.790 | 0.000 | | 0.015 |
| 3.2.1 | Under-five mortality rate (deaths per 1,000 live births) | Linear | -0.015 | 0.000 | 0.158 | 0.000 | 0.578 | 0.018 |
| | | Tobit | -0.015 | 0.000 | 0.158 | 0.000 | | 0.018 |
| | | Frac-Reg* | -0.291 | 0.000 | 0.430 | 0.002 | | 0.017 |

Source: authors' estimates.