APPENDIX

The Human Capital Index: Methodology

Components of the Human Capital Index[1]

The Human Capital Index (HCI) measures the human capital that a child born today can expect to attain by age 18, given the risks to poor health and poor education that prevail in the country where she lives. The HCI follows the trajectory from birth to adulthood of a child born today. In the poorest countries in the world, there is a significant risk that the child does not survive to her fifth birthday. Even if she does reach school age, there is a further risk that she does not start school, let alone complete the full cycle of 14 years of school from preschool to grade 12 that is the norm in rich countries. The time she does spend in school may translate unevenly into learning, depending on the quality of the teachers and schools she experiences. When she reaches age 18, she carries with her the lasting effects of poor health and nutrition in childhood that limit her physical and cognitive abilities as an adult.

The HCI quantitatively illustrates the key stages in this trajectory and their consequences for the productivity of the next generation of workers, with three components:

Component 1: Survival. This component of the index reflects the unfortunate reality that not all children born today will survive until the age when the process of human capital accumulation through formal education begins. It is measured using the under-5 mortality rate (figure A.1, panel a), with survival to age 5 as the complement of the under-5 mortality rate.

Component 2: School. This component of the index combines information on the quantity and quality of education.

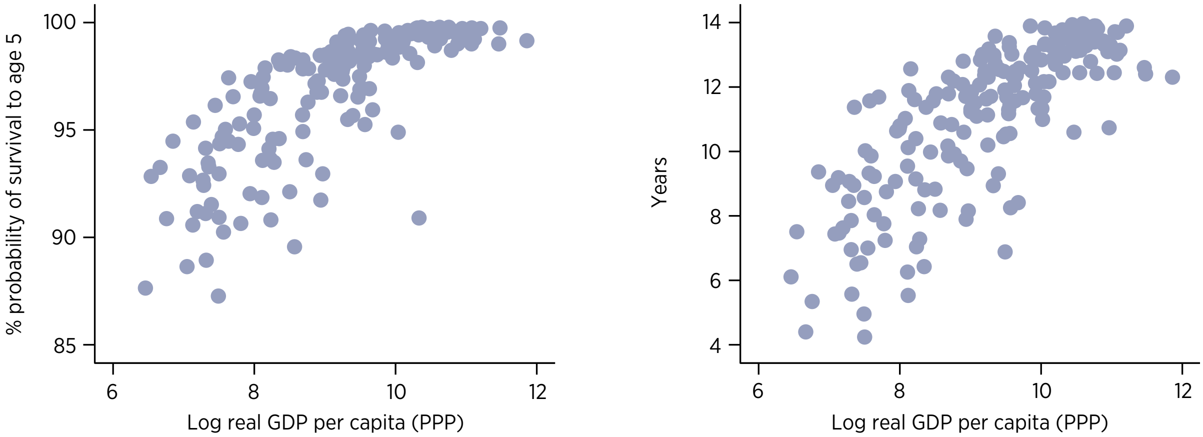
- *The quantity of education* is measured as the number of years of school a child can expect to obtain by age 18 given the prevailing pattern of enrollment rates (figure A.1, panel b). The maximum possible value is 14 years, corresponding to the maximum number of years of school obtained as of her 18th birthday by a child who starts preschool at age 4. In the data, expected years of school range from around 4 to close to 14 years.

- *The quality of education* reflects new work at the World Bank to harmonize test scores from major international student achievement testing programs into a measure of harmonized learning outcomes (HLOs).[2] HLOs are measured in units of the Trends in International Mathematics and Science Study (TIMSS) testing program and range from around 300 to around 600 across countries (figure A.1, panel c).

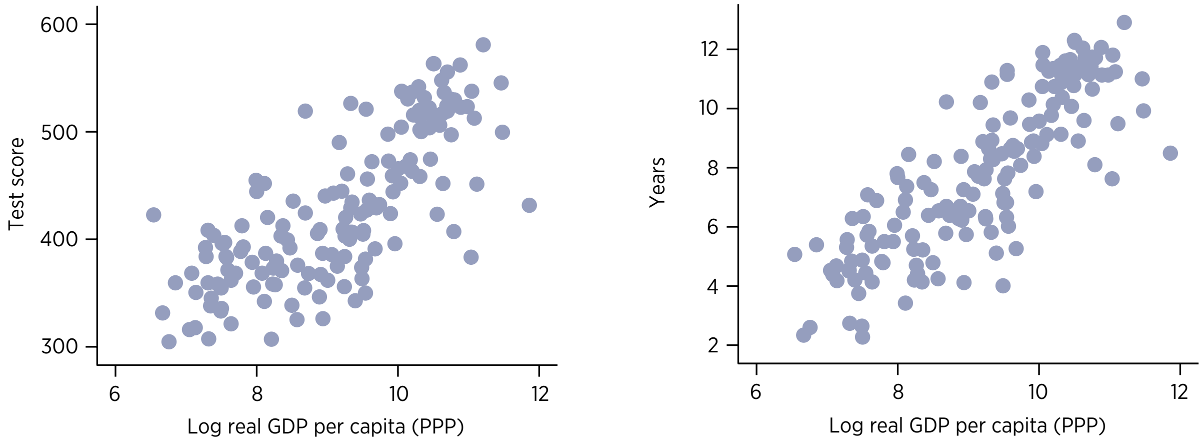
Test scores are used to convert expected years of school into learning-adjusted years of school (figure A.1, panel d). Learning-adjusted years of school are obtained by multiplying expected years of school by the ratio of test scores to 625, corresponding to the TIMSS benchmark of advanced achievement.[3] For example, if expected years of school in a country is 10 and the average test score is 400, then the country has 10 × (400/625) = 6.4 learning-adjusted years of school. The distance between 10 and 6.4 represents a learning gap equivalent to 3.6 years of school.

Component 3: Health. There is no single broadly accepted, directly measured, and widely available summary measure of health that can be used in

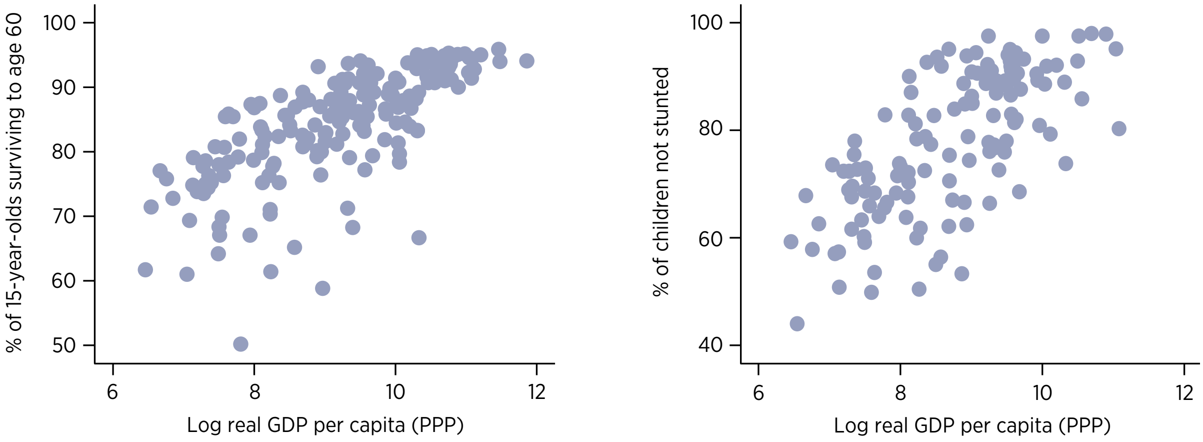
FIGURE A.1 Components of the Human Capital Index


a. Probability of survival to age 5

b. Expected years of school


c. Harmonized test scores

d. Learning-adjusted years of school


e. Adult survival rate

f. Children under 5 not stunted

Source: See "HCI data notes" section at the end of this appendix.

Note: GDP = gross domestic product; PPP = purchasing power parity.

the same way as years of school as a standard measure of educational attainment. Instead, two proxies for the overall health environment are used:

- *Adult survival rates*. This is measured as the share of 15-year-olds who survive until age 60. This measure of mortality serves as a proxy for the range of nonfatal health outcomes that a child born today would experience as an adult if current conditions prevail into the future.
- *Healthy growth among children under age 5*. This is measured using stunting rates, that is, as 1 minus the share of children under 5 who are below normal height for age. Stunting serves as an indicator for the prenatal, infant, and early childhood health environments, summarizing the risks to good health that children born today are likely to experience in their early years, with important consequences for health and well-being in adulthood.

Data on these two health indicators are shown in figure A.1, panels e and f, respectively.

Aggregation methodology

The components of the HCI are combined into a single index by first converting them into contributions to productivity.[4] Multiplying these contributions to productivity gives the overall HCI. The HCI summarizes how productive children born today will be as members of the future workforce, given the risks to education and health summarized in the components. The HCI is measured in units of productivity relative to a benchmark corresponding to complete education and full health.

In the case of survival, the relative productivity interpretation is stark: children who do not survive childhood never become productive adults. As a result, expected productivity as a future worker of a child born today is reduced by a factor equal to the survival rate, relative to the benchmark where all children survive.

In the case of education, the relative productivity interpretation is anchored in the large empirical literature measuring the returns to education at the individual level. A rough consensus from this literature is that an additional year of school raises earnings by about 8 percent.[5] This evidence can be used to convert differences in learning-adjusted years of school across countries into differences in worker productivity. For example, compared with a benchmark where all children obtain a full 14 years of school by age 18, a child who obtains only 9 years of education can expect to be 40 percent less productive as an adult (a gap of 5 years of education, multiplied by 8 percent per year).

In the case of health, the relative productivity interpretation is based on the empirical literature measuring the economic returns to better health at the individual level. The key challenge in this literature is that there is no unique directly measured summary indicator of the various aspects of health that matter for productivity. This microeconometric literature often uses proxy indicators for health, such as adult height.[6] This is because adult height can be measured directly and reflects the accumulation of shocks to health through childhood and adolescence. A rough consensus drawn from this literature is that an improvement in health associated with a 1-centimeter increase in adult height raises productivity by 3.4 percent.

Converting this evidence on the returns to one proxy for health (adult height) into the other proxies for health used in the HCI (stunting and adult survival) requires information on the relationships between these different proxies:[7]

- For stunting, there is a direct relationship between stunting in childhood and future adult height because growth deficits in childhood persist to a large extent into adulthood, together with the associated health and cognitive deficits. Available evidence suggests that an improvement in health that reduces stunting by 10.2 percentage points will lead to an improvement in worker productivity of 3.5 percent.
- For adult survival, the empirical evidence suggests that, if overall health improves, both adult height and adult survival rates increase in such a way that adult height rises by 1.9 centimeters for every 10 percentage point improvement in adult survival. This implies that an improvement in health that leads to an increase in adult survival rates of 10 percentage points is associated with an improvement in worker productivity of 1.9 × 3.4 percent, or 6.5 percent.

In the HCI, the estimated contributions of health to worker productivity based on these two alternative proxies are averaged together (if both are available) and are used individually (if only one of the two is available). The contribution of health to productivity is expressed relative to the benchmark of full health, defined as the absence of stunting, and a 100 percent adult survival rate. For example, compared with a benchmark of no stunting, in a country where the stunting rate is 30 percent, poor health reduces worker productivity by (30 × 0.35) percent, or 10 percent. Similarly, compared with the benchmark of 100 percent adult survival, poor health reduces worker productivity by (30 × 0.65) percent, or 19.5 percent, in a country where the adult survival rate is 70 percent. The average of these two estimates of the effect of health on productivity is used in the HCI.

The overall HCI is constructed by multiplying the contributions of survival, school, and health to relative productivity, as follows:

$$HCI = Survival \times School \times Health, \tag{1}$$

with the three components defined as:

$$Survival = \frac{1 - Under\text{-}5\ Mortality\ Rate}{1}, \tag{2}$$

$$School = e^{\phi\left(Expected\ Years\ of\ School \times \frac{Harmonized\ Test\ Score}{625} - 14\right)}, \tag{3}$$

$$Health = e^{\left(\gamma_{ASR} \times (Adult\ Survival\ Rate - 1) + \gamma_{Stunting} \times (Not\ Stunted\ Rate - 1)\right)/2}. \tag{4}$$

The components of the index are expressed here as contributions to productivity relative to the benchmark of complete high-quality education and full health. The parameter $\phi = 0.08$ measures the returns to an additional year of school. The parameters $\gamma_{ASR} = 0.65$ and $\gamma_{Stunting} = 0.35$ measure the improvements in productivity associated with an improvement in health, using adult survival and stunting as proxies for health. The benchmark of complete high-quality education corresponds to 14 years of school and a harmonized test score of 625. The benchmark of full health corresponds to 100 percent child and adult survival and a stunting rate of 0 percent.

These parameters serve as weights in the construction of the HCI. The weights are chosen to be the same across countries, so that cross-country differences in the HCI reflect only cross-country differences in the component variables. This facilitates the interpretation of the index. This is also a pragmatic choice because estimating country-specific returns to education and health for all countries included in the HCI is not feasible.

As shown in figure A.1, child survival rates range from around 90 percent in the highest-mortality countries to near 100 percent in the lowest-mortality countries. This implies a loss of productivity of 10 percent relative to the benchmark of no mortality. Learning-adjusted years of school range from around 3 years to close to 14 years. This gap in learning-adjusted years of school implies a gap in productivity relative to the benchmark of complete education of $e^{\phi(3-14)} = e^{0.08(-11)} = 0.4$, that is, the productivity of a future worker in countries with the lowest years of learning-adjusted school is only 40 percent of what it would be under the benchmark of complete education. For health, adult survival rates range from 60 to 95 percent, while the share of children not stunted ranges from around 60 percent to over 95 percent. Using adult survival rates indicates a gap in productivity of $e^{\gamma_{ASR}(0.6-1)} = e^{0.65(-0.4)} = 0.77$. Thus, based on adult survival rates as a proxy for health, the productivity of a future worker is only 77 percent of what it would be under the benchmark of full health. Using the share of children not stunted leads to a gap in productivity of $e^{\gamma_{Stunting}(0.6-1)} = e^{0.35(-0.4)} = 0.87$. The productivity of a future worker using the stunting-based proxy for health is therefore only 87 percent of what it would be under the benchmark of full health.

The Human Capital Index

The overall HCI is displayed in figure 3 in the main text and separately in table 2. Table A.1, which appears in a later section of this appendix, reports the overall HCI and the components for all 157 economies included in the index. The HCI data are also available at www.worldbank.org/humancapital. The HCI is higher on average in rich countries than in poor countries and ranges from around 0.3 to around 0.9. The units of the HCI have the same interpretation as the components measured in terms of relative productivity. Consider a country such as Morocco, which has an HCI of around 0.5. If current education and health conditions in Morocco persist, a child born today will be only half as productive as she could have been if she enjoyed complete education and full health.

All of the components of the HCI are measured with some error, and this uncertainty naturally has implications for the precision of the overall HCI. To capture this imprecision, the HCI estimates for each country are accompanied by upper and lower bounds that reflect the uncertainty in the measurement of the components of the HCI. These bounds are constructed by recalculating the HCI using lower- and upper-bound estimates of the components of the HCI. The upper and lower bounds are a tool to highlight to users that the estimated HCI values for all countries are subject to uncertainty, reflecting the corresponding uncertainty in the components. In cases where these intervals overlap for two countries, this indicates that the differences in the HCI estimates for these two countries should not be overinterpreted because they are small relative to the uncertainty around the value of the index itself. This is intended to help to move the discussion away from small differences in country ranks on the HCI and toward more useful discussions around the level of the HCI and what this implies for the productivity of future workers.

Another feature of the HCI is that it can be disaggregated by gender in those countries where gender-disaggregated data on all of the components of the index are available. Gender gaps are most pronounced in survival to age 5, adult survival, and stunting, where girls, on average, do better than boys in nearly all countries. The number of expected years of school is higher among girls than boys in about two-thirds of the countries, as are test scores. Overall, HCI scores are higher among girls than boys in the majority of countries.

The HCI uses the returns to education and health to convert the education and health indicators into differences in worker productivity across countries. The higher the returns, the larger the resulting worker productivity differences. The size of the returns also influences the relative contributions of education and health to the overall index. For example, if the returns to education are high, while the returns to health are low, then cross-country differences in education will account for a larger portion of cross-country differences in the index. Although varying the assumptions about the returns to education and health will affect the relative positions of countries on the index, in practice these changes are small because the health and education indicators are strongly correlated across countries.[8]

Connecting the Human Capital Index to future growth and income

The HCI can be connected to future aggregate income levels and growth following the logic of the development accounting literature. This literature typically adopts a simple Cobb-Douglas form for the aggregate production function, as follows:

$$y = Ak_p^{\alpha} k_h^{1-\alpha}, \tag{5}$$

where y is gross domestic product (GDP) per worker; k_p and k_h are the stocks of physical and human capital per worker; A is total factor productivity;

and α is the output elasticity of physical capital. To analyze how changes in human capital may affect income in the long run, rewrite the production function as follows:

$$y = \left(\frac{k_p}{y}\right)^{\frac{\alpha}{1-\alpha}} A^{\frac{1}{1-\alpha}} k_h \, . \tag{6}$$

In this formulation, GDP per worker is proportional to the human capital stock per worker, holding constant the level of total factor productivity and the ratio of physical capital to output, $\frac{k_p}{y}$. This formulation can be used to answer the question, "By how much does an increase in human capital raise output per worker in the long run after taking into account the increase in physical capital that is likely to be induced by the increase in human capital?" Equation (6) shows the answer: output per worker increases equiproportionately to human capital per worker, that is, a doubling of human capital per worker will lead to a doubling of output per worker in the long run.

Linking this framework to the HCI requires a few additional steps. First, assume that the stock of human capital per worker that enters the production function, k_h, is equal to the human capital of the average worker. Second, the human capital of the next generation, as measured in the HCI, and the human capital stock that enters the production function need to be linked. This can be done by considering different scenarios. Imagine first a status quo scenario in which the expected years of learning-adjusted school and health as measured in the HCI today persist into the future. Over time, new entrants to the workforce with status quo health and education will replace current members of the workforce until eventually the entire workforce of the future has the expected years of learning-adjusted school and health captured in the current HCI. Let $k_{h,NG} = e^{\phi S_{NG}+\gamma z_{NG}}$ denote the future human capital stock in this baseline scenario, where S_{NG} represents the number of learning-adjusted years of school of the next generation of workers, and γz_{NG} is shorthand notation for the contribution of the two health indicators to productivity in the HCI in equation (4). Contrast this with a scenario in which the entire future workforce benefits from complete education and enjoys full health, resulting in a higher human capital stock, $k_h^* = e^{\phi s^*+\gamma z^*}$, here s^* represents the benchmark of 14 years of high-quality school, and z^* represents the benchmark of full health.

Assuming that total factor productivity and the physical capital-to-output ratio are the same in the two scenarios, the eventual steady-state GDP per worker in the two scenarios is as follows:

$$\frac{y}{y^*} = \frac{k_{h,NG}}{k_h^*} = e^{\phi\left(s_{NG}-s^*\right)+\gamma\left(z_{NG}-z^*\right)} \, . \tag{7}$$

This expression is the same as the HCI in equations (1) through (4) except for the term corresponding to survival to age 5 (because children who do not survive do not become part of the future workforce). This creates a close link between the HCI and potential future growth. Setting aside the contribution of the survival probability to the HCI, equation (7) shows that a country with an HCI equal to x could achieve GDP per worker that would be $1/x$ times higher in the future if citizens enjoy complete education and full health (corresponding to $x = 1$). For example, a country such as Morocco with an HCI value of around 0.5 could, in the long run, have future GDP per worker in this scenario of complete education and full health that is $\frac{1}{0.5} = 2$ times higher than GDP per worker in the status quo scenario. What this means in terms of average annual growth rates depends on how long the long run is. For example, under the assumption that it takes 50 years for these scenarios to materialize, then a doubling of future per capita income relative to the status quo corresponds to roughly 1.4 percentage points of additional growth per year.

The calibrated relationship between the HCI and future income described here is simple because it focuses only on steady-state comparisons. In related work, Collin and Weil (2018) elaborate on this by developing a calibrated growth model that traces out the dynamics of adjustment to the steady state. They use this model to trace out trajectories for per capita GDP and for poverty measures for individual countries and global aggregates under alternative assumptions for the future path of human capital. They also calculate the equivalent increase in investment rates in physical capital that would be required to deliver the same rises in output associated with improvements in human capital.

Limitations

Like all cross-country benchmarking exercises, the HCI has limitations. Components of the HCI (see table A.1) such as stunting and test scores are measured only infrequently in some countries and not at all in others. Data on test scores come from different international testing programs that need to be converted into common units, and the age of test-takers and the subjects covered vary across testing programs. Moreover, test scores may not accurately reflect the quality of the whole education system in a country, to the extent that test-takers are not representative of the population of all students. Reliable measures of the quality of tertiary education do not yet exist, despite the importance of higher education for human capital in a rapidly changing world. The data on enrollment rates needed to estimate expected years of school often have many gaps and are reported with significant lags. Sociobehavioral skills are not explicitly captured. Child and adult survival rates are imprecisely estimated in countries where vital registries are incomplete or nonexistent.

One objective of the HCI is to call attention to these data shortcomings and to galvanize action to remedy them. Improving data will take time. In the interim and in recognition of these limitations, the HCI should be interpreted with caution. The HCI provides rough estimates of how

TABLE A.1 The Human Capital Index and components, 2018

Economy	Probability of survival to age 5	Expected years of school	Harmonized learning outcome (HLO)	Learning-adjusted years of school	Adult survival rate	Fraction of children under 5 not stunted	Human Capital Index		
							Lower bound	Value	Upper bound
Afghanistan	0.93	8.6	355	4.9	0.78	0.59	0.38	0.39	0.40
Albania	0.99	13.0	429	8.9	0.94	0.77	0.61	0.62	0.63
Algeria	0.98	11.4	374	6.8	0.91	0.88	0.51	0.52	0.53
Angola	0.92	7.9	326	4.1	0.76	0.62	0.33	0.36	0.39
Argentina	0.99	13.1	424	8.9	0.89	—	0.60	0.61	0.62
Armenia	0.99	11.1	443	7.9	0.88	0.91	0.56	0.57	0.58
Australia	1.00	13.8	524	11.6	0.95	0.98	0.79	0.80	0.81
Austria	1.00	13.9	525	11.7	0.94	—	0.78	0.79	0.80
Azerbaijan	0.98	11.6	472	8.7	0.87	0.82	0.58	0.60	0.62
Bahrain	0.99	13.3	452	9.6	0.93	—	0.65	0.67	0.68
Bangladesh	0.97	11.0	368	6.5	0.87	0.64	0.47	0.48	0.49
Belgium	1.00	13.4	519	11.1	0.93	—	0.75	0.76	0.77
Benin	0.90	9.3	384	5.7	0.76	0.66	0.38	0.41	0.43
Bosnia and Herzegovina	0.99	11.7	461	8.6	0.91	0.91	0.61	0.62	0.63
Botswana	0.96	8.4	391	5.3	0.79	0.69	0.40	0.42	0.44
Brazil	0.99	11.7	408	7.6	0.86	0.94	0.55	0.56	0.57
Bulgaria	0.99	12.9	498	10.3	0.87	—	0.65	0.68	0.70
Burkina Faso	0.92	6.5	404	4.2	0.75	0.73	0.35	0.37	0.38
Burundi	0.94	7.5	423	5.1	0.71	0.44	0.36	0.38	0.40
Cambodia	0.97	9.5	452	6.9	0.83	0.68	0.47	0.49	0.51
Cameroon	0.92	9.1	379	5.5	0.67	0.68	0.37	0.39	0.42
Canada	0.99	13.7	537	11.7	0.94	—	0.79	0.80	0.81
Chad	0.88	5.0	333	2.6	0.64	0.60	0.28	0.29	0.31
Chile	0.99	12.8	466	9.6	0.91	0.98	0.66	0.67	0.69
China	0.99	13.2	456	9.7	0.92	0.92	0.66	0.67	0.68
Colombia	0.99	12.5	424	8.5	0.86	0.89	0.58	0.59	0.61
Comoros	0.93	8.4	392	5.3	0.78	0.69	0.36	0.41	0.44
Congo, Dem. Rep.	0.91	9.2	318	4.7	0.75	0.57	0.35	0.37	0.39
Congo, Rep.	0.95	8.8	371	5.2	0.75	0.79	0.39	0.42	0.44
Costa Rica	0.99	12.5	430	8.6	0.92	0.94	0.61	0.62	0.63
Côte d'Ivoire	0.91	7.0	373	4.2	0.61	0.78	0.33	0.35	0.37
Croatia	1.00	13.3	505	10.7	0.91	—	0.71	0.72	0.74
Cyprus	1.00	13.5	502	10.9	0.95	—	0.74	0.75	0.76
Czech Republic	1.00	13.9	522	11.6	0.92	—	0.77	0.78	0.79
Denmark	1.00	13.4	531	11.4	0.93	—	0.76	0.77	0.79
Dominican Republic	0.97	11.3	350	6.3	0.84	0.93	0.48	0.49	0.51
Ecuador	0.99	13.2	420	8.9	0.88	0.76	0.59	0.60	0.61
Egypt, Arab Rep.	0.98	11.1	356	6.3	0.85	0.78	0.47	0.49	0.50
El Salvador	0.99	11.3	362	6.5	0.83	0.86	0.49	0.50	0.51
Estonia	1.00	13.1	542	11.4	0.88	—	0.73	0.75	0.76
eSwatini	0.95	8.2	440	5.7	0.59	0.74	0.38	0.41	0.43
Ethiopia	0.94	7.8	359	4.5	0.79	0.62	0.37	0.38	0.40
Finland	1.00	13.7	548	12.0	0.93	—	0.80	0.81	0.82
France	1.00	14.0	506	11.3	0.93	—	0.76	0.76	0.77
Gabon	0.95	8.3	456	6.0	0.77	0.83	0.43	0.45	0.48
Gambia, The	0.94	9.0	338	4.8	0.74	0.75	0.37	0.40	0.42
Georgia	0.99	12.5	445	8.9	0.85	0.89	0.60	0.61	0.63
Germany	1.00	13.9	528	11.7	0.93	—	0.78	0.79	0.81
Ghana	0.95	11.6	307	5.7	0.76	0.81	0.42	0.44	0.45
Greece	0.99	12.9	474	9.8	0.94	—	0.67	0.68	0.69
Guatemala	0.97	9.7	405	6.3	0.84	0.53	0.44	0.46	0.47
Guinea	0.91	7.0	408	4.5	0.75	0.68	0.35	0.37	0.39

(continued)

TABLE A.1 The Human Capital Index and components, 2018 *(continued)*

Economy	Probability of survival to age 5	Expected years of school	Harmonized learning outcome (HLO)	Learning-adjusted years of school	Adult survival rate	Fraction of children under 5 not stunted	Human Capital Index		
							Lower bound	Value	Upper bound
Guyana	0.97	12.1	346	6.7	0.79	0.89	0.48	0.49	0.51
Haiti	0.93	11.4	345	6.3	0.76	0.78	0.42	0.45	0.47
Honduras	0.98	10.0	400	6.4	0.86	0.77	0.47	0.49	0.50
Hong Kong SAR, China	0.99	13.4	562	12.1	0.95	—	0.81	0.82	0.83
Hungary	1.00	13.0	516	10.7	0.87	—	0.69	0.70	0.72
Iceland	1.00	13.4	497	10.7	0.95	—	0.73	0.74	0.75
India	0.96	10.2	355	5.8	0.83	0.62	0.43	0.44	0.45
Indonesia	0.97	12.3	403	7.9	0.83	0.66	0.52	0.53	0.55
Iran, Islamic Rep.	0.99	11.7	432	8.1	0.92	0.93	0.57	0.59	0.61
Iraq	0.97	6.9	363	4.0	0.84	0.78	0.38	0.40	0.41
Ireland	1.00	13.7	538	11.8	0.95	—	0.79	0.81	0.82
Israel	1.00	13.8	503	11.1	0.95	—	0.75	0.76	0.78
Italy	1.00	13.6	514	11.2	0.95	—	0.76	0.77	0.78
Jamaica	0.98	11.7	387	7.2	0.87	0.94	0.53	0.54	0.56
Japan	1.00	13.6	563	12.3	0.94	0.93	0.83	0.84	0.85
Jordan	0.98	11.6	409	7.6	0.89	0.92	0.54	0.56	0.58
Kazakhstan	0.99	13.3	537	11.5	0.80	0.92	0.72	0.75	0.77
Kenya	0.95	10.7	455	7.8	0.79	0.74	0.50	0.52	0.53
Kiribati	0.95	11.6	383	7.1	0.81	—	0.45	0.48	0.50
Korea, Rep.	1.00	13.6	563	12.2	0.94	0.98	0.83	0.84	0.86
Kosovo	0.99	12.8	375	7.7	0.91	—	0.55	0.56	0.57
Kuwait	0.99	12.4	383	7.6	0.92	0.95	0.56	0.58	0.59
Kyrgyz Republic	0.98	12.6	420	8.4	0.82	0.87	0.57	0.58	0.59
Lao PDR	0.94	10.8	368	6.4	0.81	0.67	0.43	0.45	0.47
Latvia	1.00	13.3	530	11.3	0.85	—	0.71	0.72	0.74
Lebanon	0.99	10.5	405	6.8	0.94	—	0.52	0.54	0.55
Lesotho	0.91	8.7	393	5.5	0.50	0.67	0.35	0.37	0.39
Liberia	0.93	4.4	332	2.3	0.77	0.68	0.31	0.32	0.33
Lithuania	1.00	13.6	514	11.2	0.83	—	0.70	0.71	0.73
Luxembourg	1.00	12.4	500	9.9	0.94	—	0.68	0.69	0.70
Macao SAR, China	0.99	12.6	545	11.0	0.96	—	0.75	0.76	0.76
Macedonia, FYR	0.99	11.2	382	6.8	0.91	0.95	0.53	0.53	0.54
Madagascar	0.96	7.5	351	4.2	0.79	0.51	0.35	0.37	0.39
Malawi	0.94	9.4	359	5.4	0.73	0.63	0.39	0.41	0.42
Malaysia	0.99	12.2	468	9.1	0.88	0.79	0.61	0.62	0.63
Mali	0.89	5.6	307	2.7	0.74	0.70	0.29	0.32	0.34
Malta	0.99	13.3	474	10.1	0.95	—	0.69	0.70	0.71
Mauritania	0.92	6.3	342	3.4	0.80	0.72	0.32	0.35	0.38
Mauritius	0.99	12.5	473	9.5	0.86	—	0.60	0.63	0.65
Mexico	0.99	12.6	430	8.6	0.89	0.88	0.60	0.61	0.61
Moldova	0.98	11.8	436	8.2	0.83	0.94	0.57	0.58	0.59
Mongolia	0.98	13.6	435	9.4	0.79	0.89	0.60	0.63	0.65
Montenegro	1.00	12.4	433	8.6	0.91	0.91	0.61	0.62	0.62
Morocco	0.98	10.6	367	6.2	0.93	0.85	0.49	0.50	0.51
Mozambique	0.93	7.4	368	4.4	0.69	0.57	0.34	0.36	0.38
Myanmar	0.95	9.9	425	6.7	0.81	0.71	0.46	0.47	0.49
Namibia	0.96	8.9	407	5.8	0.71	0.77	0.41	0.43	0.45
Nepal	0.97	11.7	369	6.9	0.85	0.64	0.48	0.49	0.50
Netherlands	1.00	13.8	530	11.7	0.94	—	0.79	0.80	0.81
New Zealand	0.99	13.6	517	11.3	0.94	—	0.76	0.77	0.78
Nicaragua	0.98	11.6	392	7.3	0.86	0.83	0.51	0.53	0.54
Niger	0.92	5.3	305	2.6	0.76	0.58	0.30	0.32	0.33

(continued)

TABLE A.1 **The Human Capital Index and components, 2018** *(continued)*

Economy	Probability of survival to age 5	Expected years of school	Harmonized learning outcome (HLO)	Learning-adjusted years of school	Adult survival rate	Fraction of children under 5 not stunted	Human Capital Index		
							Lower bound	Value	Upper bound
Nigeria	0.90	8.2	325	4.3	0.65	0.56	0.32	0.34	0.36
Norway	1.00	13.7	512	11.2	0.94	—	0.76	0.77	0.78
Oman	0.99	13.1	424	8.9	0.91	0.86	0.61	0.62	0.63
Pakistan	0.93	8.8	339	4.8	0.84	0.55	0.37	0.39	0.40
Panama	0.98	11.3	396	7.2	0.89	0.81	0.52	0.53	0.54
Papua New Guinea	0.95	8.2	358	4.7	0.78	0.50	0.36	0.38	0.40
Paraguay	0.98	11.5	386	7.1	0.86	0.94	0.51	0.53	0.55
Peru	0.99	12.7	407	8.3	0.88	0.87	0.57	0.59	0.60
Philippines	0.97	12.8	409	8.4	0.80	0.67	0.53	0.55	0.56
Poland	1.00	13.2	537	11.3	0.89	—	0.73	0.75	0.76
Portugal	1.00	13.8	520	11.5	0.93	—	0.77	0.78	0.79
Qatar	0.99	12.3	432	8.5	0.94	—	0.60	0.61	0.63
Romania	0.99	12.2	452	8.8	0.87	—	0.59	0.60	0.62
Russian Federation	0.99	13.8	538	11.9	0.78	—	0.68	0.73	0.77
Rwanda	0.96	6.6	358	3.8	0.81	0.63	0.36	0.37	0.39
Saudi Arabia	0.99	12.4	407	8.1	0.91	—	0.57	0.58	0.60
Senegal	0.95	7.2	412	4.8	0.82	0.83	0.40	0.42	0.43
Serbia	0.99	13.4	521	11.1	0.89	0.94	0.74	0.76	0.77
Seychelles	0.99	13.7	463	10.1	0.84	0.92	0.65	0.68	0.71
Sierra Leone	0.89	9.0	316	4.5	0.61	0.74	0.33	0.35	0.37
Singapore	1.00	13.9	581	12.9	0.95	—	0.87	0.88	0.90
Slovak Republic	0.99	13.0	500	10.4	0.89	—	0.68	0.69	0.71
Slovenia	1.00	13.6	532	11.6	0.93	—	0.78	0.79	0.80
Solomon Islands	0.98	9.2	362	5.3	0.86	0.68	0.43	0.44	0.45
South Africa	0.96	9.3	343	5.1	0.68	0.73	0.40	0.41	0.42
South Sudan	0.90	4.2	336	2.3	0.68	0.69	0.27	0.30	0.33
Spain	1.00	13.1	514	10.8	0.94	—	0.74	0.74	0.75
Sri Lanka	0.99	13.0	400	8.3	0.87	0.83	0.57	0.58	0.59
Sudan	0.94	7.3	380	4.4	0.78	0.62	0.37	0.38	0.39
Sweden	1.00	13.9	525	11.7	0.95	—	0.79	0.80	0.81
Switzerland	1.00	13.3	524	11.1	0.95	—	0.75	0.77	0.78
Tajikistan	0.97	10.8	444	7.7	0.87	0.73	0.51	0.53	0.55
Tanzania	0.95	7.8	388	4.8	0.79	0.66	0.39	0.40	0.41
Thailand	0.99	12.4	436	8.6	0.85	0.89	0.59	0.60	0.62
Timor-Leste	0.95	9.9	371	5.9	0.85	0.50	0.41	0.43	0.45
Togo	0.93	9.1	384	5.6	0.74	0.72	0.39	0.41	0.43
Tonga	0.98	10.9	376	6.5	0.87	0.92	0.50	0.51	0.53
Trinidad and Tobago	0.97	12.5	458	9.1	0.83	0.89	0.59	0.61	0.63
Tunisia	0.99	10.2	384	6.3	0.91	0.90	0.50	0.51	0.52
Turkey	0.99	12.1	459	8.9	0.90	0.90	0.61	0.63	0.64
Tuvalu	0.98	11.9	387	7.4	—	0.90	0.53	0.55	0.57
Uganda	0.95	7.0	397	4.4	0.70	0.71	0.37	0.38	0.39
Ukraine	0.99	13.0	490	10.2	0.81	—	0.61	0.65	0.68
United Arab Emirates	0.99	13.1	451	9.5	0.93	—	0.64	0.66	0.67
United Kingdom	1.00	13.9	517	11.5	0.94	—	0.77	0.78	0.79
United States	0.99	13.3	523	11.1	0.90	0.98	0.75	0.76	0.77
Uruguay	0.99	11.8	444	8.4	0.90	0.89	0.59	0.60	0.61
Vanuatu	0.97	10.6	356	6.1	0.87	0.72	0.45	0.47	0.48
Vietnam	0.98	12.3	519	10.2	0.88	0.75	0.65	0.67	0.68
West Bank and Gaza	0.98	11.4	412	7.5	0.89	0.93	0.54	0.55	0.56
Yemen, Rep.	0.94	8.0	321	4.1	0.78	0.54	0.35	0.37	0.38
Zambia	0.94	9.2	358	5.2	0.71	0.60	0.37	0.40	0.42
Zimbabwe	0.95	10.0	396	6.3	0.67	0.73	0.42	0.44	0.46

Source: See "HCI data notes" section at the end of this appendix.

Note: The Human Capital Index (HCI) ranges between 0 and 1. The index is measured in terms of the productivity of the next generation of workers relative to the benchmark of complete education and full health. An economy in which a child born today can expect to achieve complete education and full health will score a value of 1 on the index. Lower and upper bounds indicate the range of uncertainty around the value of the HCI for each economy.
— = not available.

current education and health will shape the productivity of future workers, but it is not a finely graduated measurement that can distinguish small differences between countries. Naturally, because the HCI captures outcomes, it is not a checklist of policy actions, and the proper type and scale of interventions to build human capital will be different in different countries. Although the HCI combines education and health into a single measure, it is too blunt a tool to inform the cost-effectiveness of policy interventions in these areas, which should instead be assessed based on careful cost-benefit analysis and impact assessments of specific programs. Because the HCI uses common estimates of the economic returns to health and education for all countries, it does not capture cross-country differences in how well countries are able to deploy productively the human capital they have. Finally, the HCI is not a measure of welfare, nor is it a summary of the intrinsic values of health and education; rather, it is simply a measure of the contribution of current health and education outcomes to the productivity of future workers.

HCI data notes

Under-5 mortality

Under-5 mortality rates are calculated by the United Nations Inter-agency Group for Child Mortality Estimation (IGME) based on mortality as recorded in household surveys and vital registries. The data are reported annually and cover 198 countries. Data from the September 2018 update of the IGME estimates are available at the Child Mortality Estimates website, http://www.childmortality.org/. The data are supplemented by data from the Global Burden of Disease (GBD) project for a few countries and territories not included in the IGME estimates.[9] The IGME estimates are disaggregated by gender and include uncertainty intervals corresponding to 95 percent certainty.

Expected years of school

The HCI includes the number of years of school a child can expect to complete by her 18th birthday, assuming she starts preschool at age 4. Expected years of school is defined as the sum of enrollment rates, by age, from ages 4 to 17 and ranges from a minimum of zero to a maximum of 14. Because age-specific enrollment rates are not systematically available for a broad cross-section of countries, more readily available data on enrollment rates by level of school are used to approximate enrollment rates in different age brackets. Specifically, preprimary enrollment rates approximate the age-specific enrollment rates among 4- and 5-year-olds; the primary rate approximates the rates among 6- to 11-year-olds; the lower-secondary rate approximates the rates among 12- to 14-year-olds; and the upper-secondary rate approximates the rates among 15- to 17-year-olds. Naturally, cross-country definitions in school starting ages and the duration of the various levels of school imply that these will only be approximations to the number of years of school a child can expect to complete by age 18.

The conceptually appropriate enrollment rate for this calculation is the repetition-adjusted total net enrollment rate. The primary source for enrollment and repetition rates is the United Nations Educational, Scientific, and Cultural Organization's Institute for Statistics (UIS), supplemented and revised using data provided by World Bank country teams that participated in an extensive data review process. In cases where the resulting data on total net enrollment rates are incomplete, adjusted net enrollment rates, net enrollment rates, or gross enrollment rates are used instead in that order of priority. The same enrollment rate is used for a given level of education over time.

The measure of expected years of school calculated here is conceptually similar to measures of "school life expectancy" calculated by the UIS. However, they differ because the UIS measure (a) is calculated using gross enrollment rates that often exceed 100 percent, sometimes by a substantial margin; (b) includes cross-country differences in the statutory duration of different levels of school; and (c) uses the UIS enrollment and repetition data as reported.[10]

Because expected years of school is constructed based primarily on administrative data on enrollment rates, uncertainty intervals are not available for this component of the HCI. Naturally, this does not imply that there is no measurement error here. An important agenda concerns the frequent and substantial discrepancies between household survey–based measures of school enrollment and administrative records. However, any uncertainty in the measurement of expected years of school is not reflected in the uncertainty intervals for the overall HCI.

There are 192 countries and territories with at least one data point on the expected years of school in the past 10 years, and the most recent observation within this period is used in the HCI.

Harmonized learning outcomes

The school quality adjustment is based on a new large-scale effort to harmonize international student achievement tests from several multicountry testing programs. A detailed description of the test score harmonization exercise is provided in Patrinos and Angrist (2018). This paper updates and expands the dataset described in Altinok, Angrist, and Patrinos (2018) that harmonized scores from three major international testing programs—the TIMSS, the Progress in International Reading Literacy Study (PIRLS), and the Programme for International Student Assessment (PISA)—as well as three major regional testing programs, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), the Program for the Analysis of Education Systems (PASEC), and the Latin American Laboratory for Assessment of the Quality of Education (LLECE). Patrinos and Angrist (2018) have subsequently updated this dataset with more recent rounds of PIRLS, PASEC, and SACMEQ, and have also substantially expanded the cross-national coverage of the database by including Early Grade Reading Assessments (EGRAs) coordinated by the U.S. Agency for International Development. The expanded dataset covers over 160 countries. In most cases, the tests are designed to be nationally representative. There are, however, some notable cases in which they are not. For example, PISA scores for China in 2009 and 2012 are based only on reported data for Shanghai and, in 2015, for Beijing, Guangdong, Jiangsu, and Shanghai.[11] The HCI uses an extrapolated estimate of nationally representative test scores for China described in Patrinos and Angrist (2018). In a number of countries, EGRAs are not nationally representative and are identified as EGRANR in the data documentation.

Test scores are converted into TIMSS units, corresponding roughly to a mean of 500 and a standard deviation across students of 100 points. The harmonization method is based on the ratio of average country scores in each program to the corresponding country scores in the numeraire testing program for the set of countries participating in both the numeraire and the other testing program. For example, consider the set of countries that participate in both the PISA and the TIMSS assessments. The ratio of average PISA scores to average TIMSS scores for this set of countries provides a conversion factor for PISA into TIMSS scores that can then be used to convert the PISA scores of all countries into TIMSS scores. The set of common countries is referred to as doubloon countries; the resulting conversion factor as the doubloon index; and the test scores in common units as harmonized learning outcomes. In the version of the data used here, the doubloon index is calculated pooling all doubloon observations between 2000 and 2017 and is therefore constant over time. This ensures that within-country fluctuations in harmonized test scores over time for a given testing program reflect only changes in the test scores themselves and not changes in the conversion factor between tests.[12]

Test scores are harmonized by subject and grade and are then averaged across subjects and grades. The most recently available test for each country is used in the HCI.[13]

Uncertainty intervals for HLOs are constructed by bootstrapping. Patrinos and Angrist (2018) take 1,000 random draws from the distribution of subject-grade average test scores for each test in their dataset. They then form doubloon indexes and calculate HLOs in each bootstrapped sample. The 2.5th and 97.5th percentiles of the distribution of the resulting HLOs across bootstrapped samples form the lower and upper bounds of the uncertainty interval for the HLO.

Learning-adjusted years of school

Learning-adjusted years of school are calculated by multiplying expected years of school by the ratio of test scores in a country to a benchmark score of 625, which corresponds to the TIMSS standard of advanced achievement. Filmer et al. (2018) provide details on the rationale for this conversion from test scores into equivalent years of school.

Adult survival rates

Adult survival rates measure the share of 15-year-olds expected to survive until age 60. They are estimated based on prevailing patterns of death rates by age and are reported by the United Nations Population Division for five-year periods. The five-year data are interpolated to arrive at annual estimates. The measurement of adult survival rates requires data on death rates by age. While these are readily available in countries with strong vital registries, such data are missing or incomplete in roughly the poorest quarter of countries. In these countries, the United Nations Population Division estimates death rates by age by linking the limited available age-specific mortality data with model life tables that capture the typical pattern in the distribution of deaths by age.

While there is uncertainty on the primary estimates of mortality as well as the process for data modeling, uncertainty intervals are not reported in the data. Instead, uncertainty intervals reported in the GBD modeling process for adult survival rates are used.[14] The point estimates for adult survival rates in these two datasets are quite similar for most countries. The ratio of the upper (lower) bound to the point estimate of the adult survival rate in the GBD data is applied to the point estimate of the adult survival rate in the United Nations data to obtain upper (lower) bounds.

Stunting

The stunting rate is defined as the share of children under the age of 5 whose height is more than two reference standard deviations below the reference median for their ages. The reference median and standard deviations are standards set by the World Health Organization (WHO) for normal healthy child development. Data on stunting rates are taken from the Joint Child Malnutrition Estimates (JME) database.[15] This dataset contains 804 country-year observations based on health surveys that directly measure the prevalence of stunting. It has been supplemented with recent surveys provided by World Bank country teams. There are 132 countries and territories with at least one stunting observation in the past 10 years, and the most recent observation within this period is used in the HCI.

The JME database reports 95 percent confidence intervals around estimates of stunting for about 40 percent of the observations, primarily those on which the JME team had access to record-level survey data and has been able to perform reanalysis. Absent better alternatives, confidence intervals are imputed for the remaining observations in the JME database using the fitted values from a regression of the width of the confidence interval on the stunting rate.

Country coverage

HCI data are reported in tables 2 and A.1 for 157 World Bank member countries and their territories, as well as for West Bank and Gaza. HCI data are not reported for some member countries where the World Bank currently does not have active operational engagement. HCI scores cannot be calculated for 33 World Bank member countries that do not participate in any of the international testing programs on which harmonized learning outcomes are based.

Notes

1. This appendix provides a summary of the methodology for the Human Capital Index. For additional details, see Kraay (2018), on which this appendix is based.
2. The methodology for harmonizing test scores is detailed in Altinok, Angrist, and Patrinos (2018) and Patrinos and Angrist (2018).
3. This methodology was introduced by the World Bank (2018) and is elaborated on in Filmer et al. (2018).
4. This approach has been used extensively in the development accounting literature (for example, Caselli 2005; Hsieh and Klenow 2010). The approach for health closely follows Weil (2007). Galasso and Wagstaff (2016) apply a similar framework to measure the costs of stunting.
5. The seminal methodology is due to Mincer (1958). See Montenegro and Patrinos (2014) for recent cross-country estimates of the returns to schooling.
6. For example, see Case and Paxson (2008); Horton and Steckel (2011).
7. For details, see Weil (2007) and Kraay (2018), section A3, and accompanying references.
8. For more details, see Kraay (2018), section A4.
9. See “Global Burden of Disease (GBD),” Institute for Health Metrics and Evaluation, University of Washington, Seattle, http://www.healthdata.org/gbd.
10. For more details on these differences, see Kraay (2018), section A2.
11. In India, the PISA was administered in two states (Himachal Pradesh and Tamil Nadu). However, a comparison with state-level scores for all of India in the 2012/13 National Achievement Survey (NAS) suggests that the average NAS score for these two states is quite similar to the national average NAS score, indicating that the 2009 PISA scores probably are roughly representative of India as a whole (see Patrinos and Angrist 2018).
12. The one exception to this is the 2007 and 2014 PASEC rounds, which were not designed to be intertemporally comparable and in which there were different doubloon countries in any case.
13. See Kraay (2018), section A3, for further details.
14. See “Global Burden of Disease (GBD),” Institute for Health Metrics and Evaluation, University of Washington, Seattle, http://www.healthdata.org/gbd.
15. See JME (UNICEF-WHO-World Bank Joint Child Malnutrition Estimates) (database), 2018 edition, United Nations Children’s Fund, New York, https://data.unicef.org/resources/jme/.

References

Altinok, Nadir, Noam Angrist, and Harry Anthony Patrinos. 2018. “Global Data Set on Education Quality (1965–2015).” Policy Research Working Paper 8314, World Bank, Washington, DC.

Case, Anne, and Christina H. Paxson. 2008. “Stature and Status: Height, Ability, and Labour Market Outcomes.” *Journal of Political Economy* 116 (3): 499–532.

Caselli, Francesco. 2005. “Accounting for Cross-Country Income Differences.” In *Handbook of Economic Growth*, vol. 1A, edited by Philippe Aghion and Steven N. Darlauf, 679–741. Amsterdam: Elsevier.

Collin, Matthew, and David N. Weil. 2018. "The Effect of Increasing Human Capital Investment on Economic Growth and Poverty: A Simulation Exercise." Policy Research Working Paper 8590, World Bank, Washington, DC.

Filmer, Deon, Halsey Rogers, Noam Angrist, and Shwetlena Sabarwal. 2018. "Learning-Adjusted Years of Schooling (LAYS): Defining a New Macro Measure of Education." Policy Research Working Paper 8591, World Bank, Washington, DC.

Galasso, Emanuela, and Adam Wagstaff. 2016. "The Economic Costs of Stunting and How to Reduce Them." With Sophie Naudeau and Meera Shekar. Policy Research Note 5 (March), World Bank, Washington, DC.

Horton, Sue, and Richard H. Steckel. 2011. "Global Economic Losses Attributable to Malnutrition 1900–2000 and Projections to 2050." Assessment Paper: Malnutrition, Copenhagen Consensus on Human Challenges, Tewksbury, MA.

Hsieh, Chang-Tai, and Peter J. Klenow. 2010. "Development Accounting." *American Economic Journal: Macroeconomics* 2 (1): 207–23.

Kraay, Aart. 2018. "Methodology for a World Bank Human Capital Index." Policy Research Working Paper 8593, World Bank, Washington, DC.

Mincer, Jacob. 1958. "Investment in Human Capital and Personal Income Distribution." *Journal of Political Economy* 66 (4): 281–302.

Montenegro, Claudio E., and Harry Anthony Patrinos. 2014. "Comparable Estimates of Returns to Schooling around the World." Policy Research Working Paper 7020, World Bank, Washington, DC.

Patrinos, Harry Anthony, and Noam Angrist. 2018. "A Global Dataset on Education Quality: A Review and an Update (1965–2018)." Policy Research Working Paper 8592, World Bank, Washington, DC.

Weil, David N. 2007. "Accounting for the Effect of Health on Economic Growth." *Quarterly Journal of Economics* 122 (3): 1265–1306.

World Bank. 2018. *World Development Report 2018: Learning to Realize Education's Promise*. Washington, DC: World Bank.