Appendix A: Calculation of the sustainability-adjusted GCI

As described in the text, the two areas of sustainability—social and environmental—are treated as independent adjustments to each country's performance in the Global Competitiveness Index (GCI). The adjustment is calculated according to the following steps.

AGGREGATION

In the first step, the individual indicators in each area are normalized on a 1-to-7 scale and aggregated by averaging the normalized scores, such that a social sustainability score and an environmental sustainability score are calculated for each country.

In the second step, these scores are normalized again on a 0.8-to-1.2 scale,[a] which is based on the distribution of each of the two sustainability components. The purpose of this methodology is to reward the countries attaining a relatively good performance on the two sustainability components while penalizing those that register a poor performance. Applying this methodology corresponds to transforming actual averages into coefficients ranging from 0.8 to 1.2. For example, the worst performer on the social sustainability pillar obtains a score of 0.8 and the best performer a 1.2. The same calculation is conducted for the environmental sustainability pillar.

Normalizing on a 0.8-to-1.2 scale and using the actual sample maximum and minimum are corroborated by the statistical distribution of the data, so as to ensure that the final data are not skewed. In the absence of empirical evidence, the selection of the impact limits (0.8–1.2) relies on the best judgment of the authors and is based on the assumption that countries can experience either an opportunity if they manage their resources well or a weakness if they do not.

The selection of this methodology is not intended to be scientific, but it represents a normative approach aimed at stimulating discussions on policy priorities and possibly stimulating scientific research in this field.

In the third step, the GCI score of each country is multiplied twice: once by its social sustainability coefficient and once by its environmental sustainability coefficient, to obtain two separate sustainability-adjusted GCI scores. Finally, an average of the two scores provides an overall measure of the sustainability adjustment.

STRUCTURE OF THE SUSTAINABILITY PILLARS

The computation of the sustainability components is based on an arithmetic mean aggregation of scores from the indicator level.[b]

Variables that are not derived from the Executive Opinion Survey (the Survey) are identified by an asterisk (*) in the following pages. To make the aggregation possible, these variables are transformed into a 1-to-7 scale in order to align them with the Survey results. We apply a min-max transformation, which preserves the order of, and the relative distance between, country scores.[c]

Indicators marked with a "(log)" subscript are transformed applying the logarithm (base 10) to the raw score.

Social sustainability pillar

S01 Income Gini index*
S02 Youth unemployment*
S03 Access to sanitation*[d] $_{(log)}$
S04 Access to improved drinking water*[d]
S05 Access to healthcare[d]
S06 Social safety net protection
S07 Extent of informal economy
S08 Social mobility
S09 Vulnerable employment*

Environmental sustainability pillar

S10 Stringency of environmental regulation[e]
S11 Enforcement of environmental regulation[e]
S12 Terrestrial biome protection*
S13 No. of ratified international environmental treaties*
S14 Agricultural water intensity*
S15 CO_2 intensity*$_{(log)}$
S16 Fish stocks overexploited*$_{(log)}$
S17 Forest cover change*
S18 Particulate matter (2.5) concentration*(log)
S19 Quality of the natural environment

NOTES

a Formally we have

$$0.4 \times \left(\frac{\text{country score} - \text{sample minimum}}{\text{sample maximum} - \text{sample minimum}} \right) + 0.8$$

The *sample minimum* and *sample maximum* are, respectively, the lowest and highest country scores in the sample of economies covered by the sustainability-adjusted GCI in each pillar.

b Formally, for a category *i* composed of *K* indicators, we have:

$$category_i = \frac{\sum_{k=1}^{K} indicator_k}{K}$$

c Formally, we have:

$$6 \times \left(\frac{\text{country score} - \text{sample minimum}}{\text{sample maximum} - \text{sample minimum}} \right) + 1$$

The *sample minimum* and *sample maximum* are, respectively, the lowest and highest country scores in the sample of economies covered by the sustainability-adjusted GCI. In some instances, adjustments were made to account for extreme outliers. For those indicators for which a higher value indicates a worse outcome (e.g., CO_2 emission, income Gini index), the transformation formula takes the following form, thus ensuring that 1 and 7 still corresponds to the worst and best possible outcomes, respectively:

$$-6 \times \left(\frac{\text{country score} - \text{sample minimum}}{\text{sample maximum} - \text{sample minimum}} \right) + 7$$

d Variables S03, S04, and S05 are combined to form one single variable.

e Variables S10 and S11 are combined to form one single variable.

Appendix B: Technical notes and sources for sustainability indicators

The data in this *Report* represent the best available estimates from various national authorities, international agencies, and private sources at the time the *Report* was prepared. It is possible that some data will have been revised or updated by the sources after publication. Throughout the *Report,* "n/a" denotes that the value is not available or that the available data are unreasonably outdated or do not come from a reliable source.
For each indicator, the title appears on the first line, preceded by its number to allow for quick reference. The numbering is the same as the one used in Appendix A. Below is a description of each indicator or, in the case of Executive Opinion Survey data, the full question and associated answers. If necessary, additional information is provided underneath.

S01 Income Gini coefficient

Measure of income inequality (0 = perfect equality; 100 = perfect inequality) | 2011 or most recent available

This indicator measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.

Sources: The World Bank, *World Development Indicators Online* (retrieved May 27, 2013); US Central Intelligence Agency, *The World Factbook* (retrieved June 6, 2013); national sources

S02 Youth unemployment

Percent of total unemployed youth to total labor force aged 15–24 | 2010 or most recent available

Youth unemployment refers to the share of the labor force aged 15–24 without work but available for and seeking employment.

Sources: International Labour Organization, *Key Indicators of the Labour Markets Net* (retrieved June 5, 2013) ;The World Bank, *World Development Indicators Online* (retrieved May 27, 2013); national sources

S03 Access to sanitation

Percent of total population using improved sanitation facilities | 2011 or most recent available

Share of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained.

Source: World Health Organization, *World Health Statistics 2013* (online database, retrieved June 5, 2013)

S04 Access to improved drinking water

Percent of the population with access to improved drinking water | 2011 or most recent available

Share of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, or rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 liters per person per day from a source within 1 kilometer of the dwelling.

Source: World Health Organization, *World Health Statistics 2013* (online database retrieved June 5, 2013)

S05 Accessibility of healthcare services

How accessible is healthcare in your country? [1 = limited, only the privileged have access; 7 = universal, all citizens have access to healthcare] | 2012–2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions

S06 Social safety net protection

In your country, does a formal social safety net provide protection from economic insecurity due to job loss or disability? [1 = not at all; 7 = fully] | 2012–2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions

S07 Extent of informal economy

How much economic activity in your country would you estimate to be undeclared or unregistered? [1 = most economic activity is undeclared or unregistered; 7 = most economic activity is declared or registered] | 2012–2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions

S08 Social mobility

To what extent do individuals in your country have the opportunity to improve their economic situation through their personal efforts regardless of the socioeconomic status of their parents? [1 = little opportunity exists to improve one's economic situation; 7 = significant opportunity exists to improve one's economic situation] | 2012–2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions

S09 Vulnerable employment

Proportion of own-account and contributing family workers in total employment | 2011 or most recent year available

Vulnerable employment refers to unpaid family workers and own-account workers as a percentage of total employment—that is, the share of own-account and contributing family workers in total employment. A *contributing family worker* is a person who is self-employed in a market-oriented establishment operated by a related person living in the same household, and who cannot be regarded as a partner because of the degree of his or her commitment to the operation of the establishment, in terms of the working time or other factors to be determined by national circumstances, is not at a level comparable with that of the head of the establishment.

Source: The World Bank, *World Development Indicators Online* (retrieved May 26, 2013)

S10 Stringency of environmental regulations

How would you assess the stringency of your country's environmental regulations? [1 = very lax ; 7 = among the world's most stringent] | 2012–2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions

S11 Enforcement of environmental regulations

How would you assess the enforcement of environmental regulations in your country? [1 = very lax ; 7 = among the world's most rigorous] | 2012-2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions

S12 Terrestrial biome protection

Degree to which a country achieves the target of protecting 17 percent of each terrestrial biome within its borders | 2010 or most recent year available

This indicator is calculated by CIESIN (Columbia University's Center for International Earth Science Information Network) by overlaying the protected area mask on terrestrial biome data developed by the World Wildlife Fund (WWF)'s Terrestrial Ecoregions of the World for each country. A *biome* is defined as a major regional or global biotic community, such as a grassland or desert, characterized chiefly by the dominant forms of plant life and the prevailing climate. Scores are capped at 17 percent per biome such that higher levels of protection of some biomes cannot be used to offset lower levels of protection of other biomes, hence the maximum level of protection a country can achieve is 17 percent. CIESIN uses time series of the World Database on Protected Areas (WDPA) developed by the United Nations Environment Programme (UNEP) World Conservation Monitoring Centre (WCMC) in 2011, which provides a spatial time series of protected area coverage from 1990 to 2010. The WCMC considers all nationally designated protected areas whose location and extent is known. Boundaries were defined by polygons where available, and where they were not available protected area centroids were buffered to create a circle in accordance with the protected area size. The WCMC removed all overlaps between different protected areas by dissolving the boundaries to create a protected areas mask.

Source: Yale University and Columbia University, Environmental Performance Index (EPI) 2012 edition based on WWF World Wildlife Fund USA and UNEP World Conservation Centre data

S13 No. of ratified international environmental treaties

Total number of ratified environmental treaties | 2012

This variable measures the total number of international treaties from a set of 25 for which a state is a participant. A state is acknowledged as a "participant" whenever its status for each treaty appears as "Ratified," "Accession," or "In Force." The treaties included are: the International Convention for the Regulation of Whaling, 1948 Washington; the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, as amended in 1962 and 1969, 1954 London; the Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 Ramsar; the Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972 Paris; the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 London, Mexico City, Moscow, Washington; the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973 Washington; the International Convention for the Prevention of Pollution from Ships (MARPOL) as modified by the Protocol of 1978, 1978 London; the Convention on the Conservation of Migratory Species of Wild Animals, 1979 Bonn; the United Nations Convention on the Law of the Sea, 1982 Montego Bay; the Convention on the Protection of the Ozone Layer, 1985 Vienna; the Protocol on Substances that Deplete the Ozone Layer, 1987 Montreal; the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 Basel; the International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 London; the United Nations Framework Convention on Climate Change, 1992 New York; the Convention on Biological Diversity, 1992 Rio de Janeiro; the International Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly Africa, 1994 Paris; the Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, 1994 New York; the Agreement relating to the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995 New York; the Kyoto Protocol to the United Nations Framework Convention on the Climate Change, Kyoto 1997; the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, 1998 Rotterdam; the Cartagena Protocol of Biosafety to the Convention on Biological Diversity, 2000 Montreal; the Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 London; the Stockholm Convention on Persistent Organic Pollutants, 2001 Stockholm; the International Treaty on Plant Genetic Resources for Food and Agriculture, 2001 Rome; the International Tropical Timber Agreement, 2006 Geneva.

Source: The International Union for Conservation of Nature (IUCN) Environmental Law Centre ELIS Treaty Database

S14 Agricultural water intensity

Agricultural water withdrawal as a percent of total renewable water resources | 2009 or most recent year available

Agricultural water withdrawal as a percent of total renewable water resources is calculated as: 100 × agricultural water withdrawal / total renewable water resources. In turn, total renewable = surface renewable water + renewable water resources groundwater – overlap between surface and groundwater. Where available, this indicator includes water resources coming from desalination used for agriculture (as in Kuwait, Saudi Arabia, the United Arab Emirates, Qatar, Bahrain, and Spain).

Source: FAO AQUASTAT database, available at http://www.fao.org/nr/water/aquastat/main/index.stm (retrieved May 24, 2013)

S15 CO_2 intensity

CO_2 intensity (kg of CO_2 per kg of oil equivalent energy use) | 2009

Carbon dioxide (CO_2) emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include CO_2 produced during consumption of solid, liquid, and gas fuels and gas flaring. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. A logarithm transformation is applied to the ratio of these statistics in order to spread the data distribution.

Source: The World Bank, *World Development Indicators Online* (retrieved May 27, 2013)

S16 Fish stocks overexploited

Fraction of country's exclusive economic zone with overexploited and collapsed stocks | 2006

The See Around Us (SAU) project's Stock Status Plots (SSPs) are created in four steps (Kleisner and Pauly, 2011). In the first step, SAU defines a *stock* as a taxon (at the species, genus, or family level of taxonomic assignment) that occurs in the catch records for at least 5 consecutive years, over a minimum span of 10 years, and that has a total catch in an area of at least 1,000 tonnes over the time span. In the second step, SAU assesses the status of the stock for every year relative to the peak catch. SAU defines five states of stock status for a catch time series. This definition is assigned to every taxon that meets the definition of a stock for a particular spatial area (e.g., exclusive economic zones, or EEZs). These states are: (1) Developing—before the year of peak catch and less than 50 percent of the peak catch; (2) Exploited—before or after the year of peak catch and more than 50 percent of the peak catch; (3) Overexploited—after the year of peak catch and less than 50 percent but more than 10 percent of the peak catch; (4) Collapsed—after the year of peak catch and less than 10 percent of the peak catch; and (5) Rebuilding—after the year of peak catch and after the stock has collapsed, when catch has recovered to between 10 percent and 50 percent of the peak. In the third step, SAU graphs the number of stocks by status in a given year by tallying the number of stocks in a particular state and presenting these as percentages. In the final step, the cumulative catch of stock by status in a given year is summed over all stocks and presented as a percentage in the catch by stock status graph. The combination of these two figures represents the complete Stock Status Plot. The numbers for this indicator are taken from the overexploited and collapsed numbers of stocks over total numbers of stocks per EEZ. A logarithm transformation is applied to these statistics in order to spread the data distribution.

Source: Yale University and Columbia University, Environmental Performance Index (EPI) 2012 edition based on Sea Around Us data

S17 Forest cover change

Average percent change in forest area per year between 1990 and 2010 | 2010

This measure represents the percent change in forest area, applying a 10 percent crown cover as the definition of forested areas, between time periods. We used total forest extent rather than the extent of primary forest only. The change measure is calculated from forest area data in 1995, 2000, 2005, and 2010. The data are reported by national governments, and therefore methods and data sources may vary from country to country. Positive values indicate afforestation or reforestation, and negative values represent deforestation.

Source: Yale University and Columbia University, Environmental Performance Index (EPI) 2012 edition based on FAO data

S18 Particulate Matter (2.5) concentration

Population-weighted exposure to $PM_{2.5}$ in micro-grams per cubic meter, based on satellite data | 2009

This indicator is based on satellite data that are then converted to ground-level concentrations using the GEOS-Chem global chemical transport model to account for the meteorological and chemical factors that influence the spatially and temporally varying relationship between column and surface concentrations. The 0.1 × 0.1 resolution aerosol optical depth (AOD) values for 2001–05 are derived from the NASA Terra MODIS and MISR sensors, averaged to get a six-year mean AOD for each grid cell, and then population-weighted to better represent human exposure by country. $PM_{2.5}$ concentrations were averaged over the period 2001–05 and the grid was resampled to match the Global Rural-Urban Mapping Project 1 kilometer population grid. The weighted average of the values in each grid cell was used to derive a country total exposure to $PM_{2.5}$ in micrograms per cubic meter. A logarithm transformation is applied to these statistics in order to spread the data distribution.

Source: Yale University and Columbia University, Environmental Performance Index (EPI) 2012 edition based on NASA MODIS and MISR data (van Donkelaar et al. 2010), Battelle, and CIESIN

S19 Quality of natural environment

How would you assess the quality of the natural environment in your country? [1 = extremely poor; 7 = among the world's most pristine] | 2012–2013 weighted average

Source: World Economic Forum, Executive Opinion Survey, 2012 and 2013 editions