

APPENDIX 1

Index methodology: data normalization, aggregation, and index construction

The Women’s Peace and Security (WPS) Index is a summary measure capturing achievements in women’s well-being in three dimensions: inclusion, justice, and security.

Two steps are basic in estimating any index: normalization and aggregation. The policy and academic literature on composite indices provide a robust foundation for our approach to both steps.⁷⁵ This appendix describes the steps in calculating the sub-indices and the overall WPS Index and presents a worked-through example.

Normalization

Normalization makes data comparable across indicators, so that the information can be combined in a meaningful way. For example, all indicators need to be estimated such that higher or lower values consistently mean that the achievement is better or worse. A typical approach is to rescale the set of values from 0 to 100, with 0 denoting worst performance and 100 describing the optimum. This is done for the Sustainable Development Goals Index (SDGI) developed by Schmidt-Traub et al. (2017),⁷⁶ the Africa Gender Equality Index (AGEI) developed by the African Development Bank in 2015, and the Human Development Index (HDI) published by the United Nations Development Programme, for example.

The values for several indicators in the WPS Index fall naturally between 0 and 100—for example, all those presented as percentages (financial inclusion, employment, cellphone use, intimate partner violence, and community safety). Other indicators require setting maximum values. We set

aspirational maximum values of 15 years for mean years of schooling and 50 percent for parliamentary representation. The goal posts are laid out in table A1.1 below.

Rescaling is sensitive to the choice of limits and extreme values (outliers) at both tails of the distribution. Where the observed data range for a particular indicator is wide, the indicator acquires a larger implicit weight, and outliers can have undue influence. Setting upper and lower bounds can reduce spurious variability, although this needs to be done with care.

Unless otherwise indicated, indicators are normalized as follows:

$$\text{Indicator score} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

Aggregation

The Sustainable Development Goals (SDGs) were adopted as an “integrated and indivisible” set of goals, and we sought to respect that principle by giving equal weight to each of the three dimensions in the WPS Index.

Aggregation proceeded in two steps. First, the normalized variables (indicators) were aggregated for each dimension and then aggregated across the three dimensions of the WPS Index. The arithmetic mean was used to aggregate indicator scores within each dimension, reflecting the broadly complementary nature of the indicators. The relative weight of each indicator in a dimension is inversely proportional to the number of indicators in that dimension.

TABLE A1.1 Minimum and maximum values for component indicators of the index

Dimension and indicator	Minimum value	Maximum value
Inclusion		
Education	0	15
Financial inclusion	0	100
Employment	0	100
Cellphone use	0	100
Parliamentary representation	0	50
Justice		
Legal discrimination	84	0
Son bias	1.2	0.9 ^a
Discriminatory norms	100	0
Security		
Community safety	0	100
Intimate partner violence	100	0
Organized violence	200	0

a. Biased against male births (biased in favor of female births).
Source: Authors.

Arithmetic means were used to aggregate the normalized indicators into each dimension sub-index:

- *Inclusion sub-index* = (Education score + Financial inclusion score + Employment score + Cellphone use score + Parliamentary representation score)/5.
- *Justice sub-index* = (Legal discrimination score + Son bias score + Discriminatory norms score)/3.
- *Security sub-index* = (Intimate partner violence score + Community safety score + Organized violence score)/3.

To emphasize that all three dimensions are equally important and that countries are expected to perform well on each dimension, we then used a geometric mean to aggregate the three dimension sub-indices into the overall WPS Index:

- *WPS Index* = Inclusion sub-index^{1/3} × Justice sub-index^{1/3} × Security sub-index^{1/3}.

Figure A1.1 summarizes how the WPS Index is constructed.

The geometric mean is often used to aggregate heterogeneous variables with limited substitutability, because this method penalizes unequal achievements across dimensions.⁷⁷ By way of contrast, an arithmetic mean would allow for perfect substitutability across dimensions—for example, a very good score on inclusion could fully compensate for a poor score on security—which is not consistent with the spirit and objectives of the WPS Index.

A worked-through example: China

We use China's scores from statistical table 1 (as shown in table A1.2) to illustrate the application of our method.

That example demonstrates how the arithmetic mean of the indicator scores within each dimension is used to aggregate the scores within each dimension and then how the geometric mean is used to aggregate the three dimension sub-indices into the WPS Index.

Inclusion dimension

- Education = $(7.01 - 0)/(15 - 0) = .467$
- Financial inclusion = $(76.36 - 0)/(100 - 0) = .763$
- Employment = $(64.2 - 0)/(100 - 0) = .642$
- Cellphone use = $(89.54 - 0)/(100 - 0) = .895$
- Parliamentary representation = $(23.7 - 0)/(50 - 0) = .474$

Inclusion sub-index =

$$(.467 + .763 + .642 + .895 + .474) / 5 = .648$$

Justice dimension

- Legal discrimination = $1 - (24/84) = .7143$
- Son bias⁷⁸ = $(1.2 - 1.16)/(1.2 - 1.05) = .267$
- Discriminatory norms = $1 - (19/100) = .810$

Justice sub-index =

$$(.714 + .267 + .810) / 3 = .597$$

Security dimension

- Community safety = $(72.8 - 0)/(100 - 0) = .728$
- Intimate partner violence = $1 - (38.7 - 0)/(100 - 0) = .613$
- Organized violence = $[1 - (0/200)^{1/3}]^3 = 1$

Security sub-index =

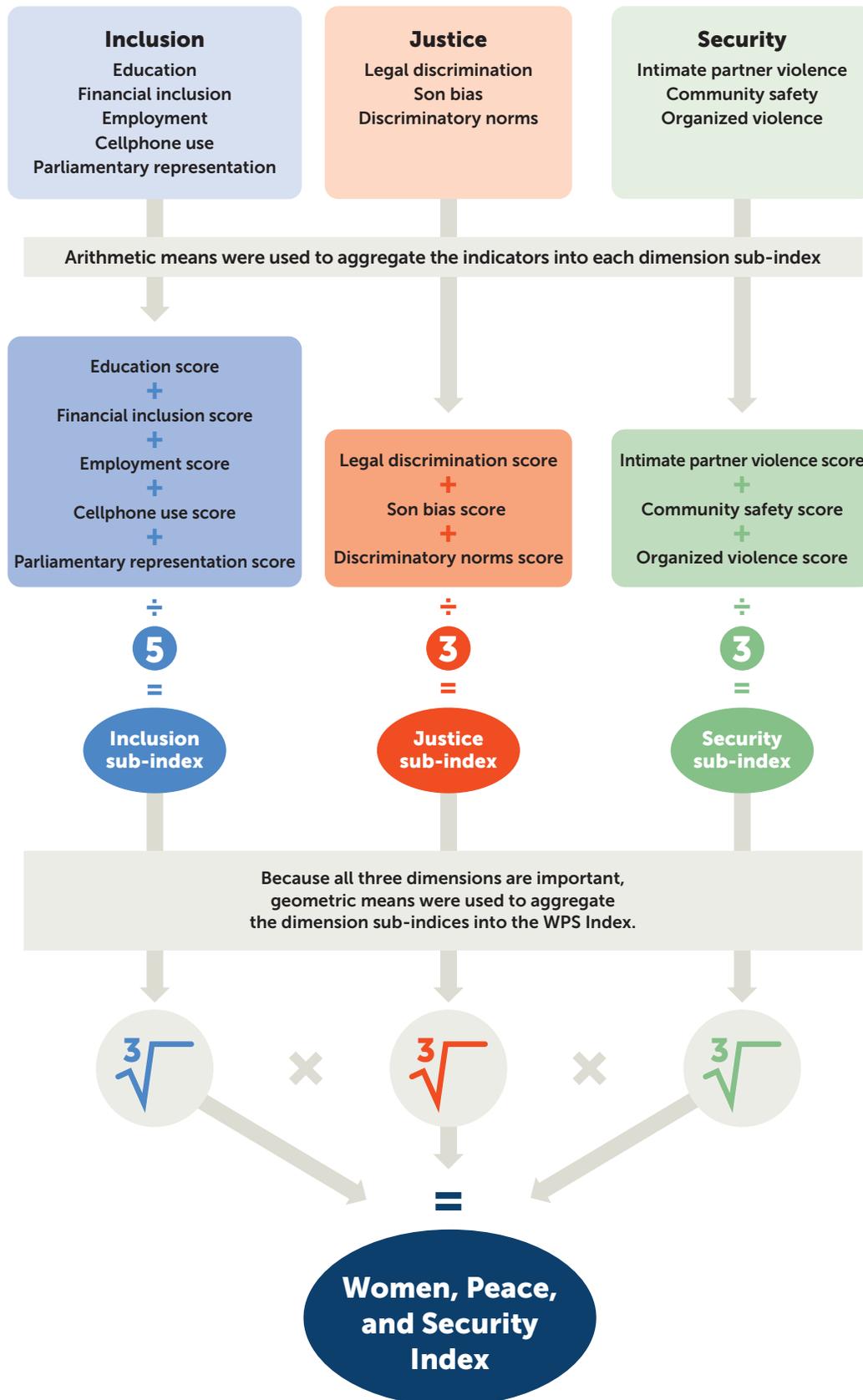
$$(.7281 + .613 + 1) / 3 = .780$$

$$\text{China's WPS Index} = .648^{1/3} \times .597^{1/3} \times .780^{1/3} = .671$$

TABLE A1.2 Illustration of aggregation with China as an example

Indicator	Value for China
Education (mean years)	7.0
Financial inclusion (%)	76.4
Employment (%)	64.2
Cellphone use (%)	89.5
Political participation (%)	23.7
Legal discrimination (0–84)	24
Son bias (male/female ratio)	1.16
Discriminatory norms (%)	19
Community safety (%)	72.8
Intimate partner violence (%)	38.7
Organized violence (per 100,000 people)	0.0

Source: See statistical table 1.

FIGURE A1.1 Construction of the Women, Peace, and Security Index

Source: Authors.