

Latent Variable Scales for Women's Inclusion, Women's  
Rights, and Women's Security

August 8, 2018

# 1 CONCEPTS

**Women’s inclusion** is conceptualized as “sex” parity in public spaces. Sex refers to the biological and genotypical characteristics that make “boys” boys and “girls” girls. It does not refer to the social roles associated with that distinction. Sex parity therefore captures the degree to which women’s physical bodies are represented in the public sphere. Are women visible in public spaces?

**Women’s rights** refer to the legal structures in place to protect women. The concept does not capture the actual condition of women on the ground (i.e. women moving freely, owning property, etc.), but rather the legal and policy framework available for their protection (i.e. laws that enable women to move freely, buy property, etc.). Are there legal structures to protect women from harm?

**Women’s security** is defined as human security<sup>1</sup> applied to women specifically, and covers a broad range of ways harm can come to women. More specifically, women’s security means *women’s* safety from chronic threats such as hunger, disease and repression and it means protection from sudden and hurtful disruptions in daily life—whether in homes, in jobs or in communities. It means freedom from pervasive threats to *women’s* safety or lives, or protection for *women* from threats to survival, daily life, and dignity. Are women free from harm?

For each scale, higher values correspond to better conditions for women: more security, greater inclusion, and more extensive rights. Data for each scale include a score for each country-year (labeled “Mean”), as well as a standard deviation (labeled “SD”) and the lower

---

<sup>1</sup>According to the UN, human security means “safety from such chronic threats as hunger, disease and repression and it means protection from sudden and hurtful disruptions in the patterns of daily life—whether in homes, in jobs or in communities” UNDP (1994, p. 22).

and upper bounds of the 95% credible interval for the score (“2.5” and “97.5”). When using the scales it is important to account for the uncertainty in the scores. The model estimates a posterior *distribution* of scores for each observation rather than a single estimate. When reporting scores for individual country-years, it is necessary to report the mean score as well as a plausible range of values for the score. The upper and lower bounds of the credible intervals are useful for this purpose. When using the estimates in a statistical model, e.g. a regression model, users can account for the uncertainty by taking  $N$  draws from each posterior distribution and estimating their model  $N$  times. The mean scores and standard deviations can be used for this purpose. After estimating  $N$  models, estimates can be pooled using the same formula one would use for multiply imputed data sets.

## 2 INDICATORS

To measure each concept we combine many different variables obtained from several sources: the World Bank (their Gender Statistics dataset and also their Women, Business and the Law dataset), the UNDP, the OECD, the Varieties of Democracy data (Coppedge et al. 2017), and the Woman Stats data project (Caprioli et al. 2009). The World Bank’s Gender Statistics data set is compiled from many different sources, including the USAID-funded Demographic and Health Surveys, the International Labor Organization (ILO), various UN agencies and programs, the World Bank’s Global Financial Inclusion (GFI) data set (Demirgüç-Kunt et al. 2015), and the OECD. We combine these indicators into scales using Bayesian mixed factor analytic models, which can accommodate variables at different levels of measurement (continuous, binary, etc.). The inclusion model features 35 variables related to women’s inclusion in education, political institutions, and the workforce. The inclusion variable covers 174 countries for the years 1973-2014. Our security model includes 47 variables that measure the extent to which women are economically vulnerable and/or dependent on men for material well being, exposure to the risk of bodily harm from physical violence or medical

conditions (including lack of access to family planning resources and proper prenatal care), and male dominance in everyday decision-making. Our rights model features 75 variables related to formal law, including laws related to freedom of movement for women, domestic violence, and property and suffrage rights. The security and rights variables cover the years 1960-2014.

Here we provide additional information about our measurement models. We use a mix of continuous, binary, and ordinal indicators. Continuous indicators were assumed to follow normal distributions, and were all standardized prior to estimation. Formally, for any continuous indicator  $y_j$  we assume:

$$y_{ij} \sim \mathcal{N}(\mu_{ij}, \sigma_j^2)$$

$$\mu_{ij} = \beta_j X_i$$

Where  $X_i$  is the latent variable and  $\beta$  is a “factor loading” that indicates the direction and strength of the relationship between the latent variable and the observed indicator in question. For binary indicators we assume:

$$y_{ij} \sim \text{Bernoulli}(p_{ij})$$

$$\text{logit}(p_{ij}) = \alpha_j + \beta_j X_i$$

Where  $\alpha$  is a “difficulty” parameter that indicates the value of the latent variable at which the binary outcome becomes 1, and  $\beta$  is a “discrimination” parameter that indicates how quickly  $\Pr(y_{i,j} = 1)$  changes as the latent variable increases. Ordinal variables are assumed to follow categorical distributions with  $J$  categories, where:

$$\Pr(y_i = 1|X_{i,t}) = \Phi(\tau_1 - \beta X_{i,t})$$

$$\Pr(y_i = j|X_{i,t}) = \Phi(\tau_j - \beta X_{i,t}) - \Phi(\tau_{j-1} - \beta X_{i,t})$$

$$\Pr(y_i = J|X_{i,t}) = 1 - \Phi(\tau_{J-1} - \beta X_{i,t})$$

Where  $\Phi$  is the c.d.f. of the standard normal distribution and the  $\tau$ s are “cut-point” param-

eters that indicate the value of the latent variable at which the observed variable changes categories.

In each model  $X$  is assigned a normal prior distribution with mean 0 and variance 1. This is a standard assumption made to identify the model. Each  $\alpha$  is assigned a normal prior with mean 0 and variance 10. Most of the  $\beta$ s are given normal prior distributions with mean 0 and variance 10. Due to the “rotational invariance” problem inherent to latent variable models, some of the parameters in the model must be restricted for identification (Bollen 1989).<sup>2</sup> For this reason, in each model several of the  $\beta$  parameters are restricted to be positive or negative. Each of the constrained  $\beta$ s have truncated (at zero) normal prior distributions with mean -2, -1 or 1 and variance 10. In addition to helping identify the model, these restrictions also orient the latent variables so that higher values on each scale correspond to higher values of the concept in question. For each continuous indicator the  $\sigma^2$  parameter has a Gamma prior distribution with shape and rate parameters of 10. For each model we ran 2 Markov chains for at least 3,000 iterations and stored the last 1,000 to summarize the posterior distributions of the parameters. Visual diagnostics and a Gelman-Rubin test (Gelman and Rubin 1992) showed no signs of non-convergence.

We obtained the data used in the measurement models from the World Bank’s Gender Statistics and Women, Business and the Law datasets, the UNDP, the OECD, the Varieties of Democracy data (Coppedge et al. 2017), and the Woman Stats data project (Caprioli et al. 2009).<sup>3</sup> The World Bank’s Gender Statistics data set is compiled from many different sources, including the USAID-funded Demographic and Health Surveys, the International Labor Organization (ILO), various UN agencies and programs, the World Bank’s Global Financial Inclusion (GFI) data set (Demirgüç-Kunt et al. 2015), and the OECD. Table 1–3

---

<sup>2</sup>Rotational invariance means the parameters in the model could all be “rotated,” i.e. have their signs reversed, and the fit of the model to the data would not be affected.

<sup>3</sup>An obvious omission is the Cingranelli-Richards Human Rights Data Project (Cingranelli, Richards and Clay 2014), used in several studies listed in Tables 1 and 2 of the body of the manuscript. We do not use these indicators because they measure both law and practice, which we wish to keep separate.

lists the observed indicators included in each model along with their original sources.

Table 1: Observed Indicators for Women’s Inclusion Model

Source	Indicator
Demographic and Health Surveys	Proportion that do not own land, ratio
ILO	Contributing family workers (of employed), ratio
	Ratio of female to male labor force participation rate
	Wage and salaried workers (of employed), ratio
UN Statistics Division	Avg. hours spend on unpaid domestic work, ratio
UNESCO	Children out of primary school, ratio
	Completed bachelor’s degree (25 yrs+), ratio
	Completed doctoral degree, ratio
	Completed lower secondary, ratio
	Completed masters degree, ratio
	Completed no schooling, ratio
	Completed primary, ratio
	Completed tertiary, ratio
	Completed upper secondary, ratio
	Expected years of schooling, ratio
	Graduation rate at lower secondary, ratio
	Primary enrollment rate, ratio
	Secondary enrollment rate, ratio
	Tertiary enrollment rate, ratio
V Dem	Female head of government
	Proportion of female cabinet members
	Proportion of female legislators
World Bank Gender Statistics	Female share of graduates in agriculture, tertiary
	Female share of graduates in education, tertiary
	Female share of graduates in engineering/manufacturing/construction, tertiary
	Female share of graduates in health, tertiary
	Female share of graduates in humanities and arts, tertiary
	Female share of graduates in science, tertiary
	Female share of graduates in services, tertiary

World Bank WBL	Female share of graduates in social science/business/law, tertiary
	Female share of professional and technical workers
	Female chief justice
	Proportion of female high court justices
	Proportion of firms with female participation in ownership
	Used an account to receive wages, ratio

Table 2: Observed Indicators for Women's Security Model

Source	Indicator
Demographic and Health Surveys	Contraceptive prevalence
	Decisions about major household purchases made mainly by husband
	Decisions about woman's own healthcare made mainly by her
	Decisions about woman's visits to family/relatives made mainly by her
	Demand for family planning satisfied (of married women)
	Participation rate in decisions about daily purchases
	Participation rate in decisions about major household purchases
	Participation rate in decisions about own health care
	Participation rate in decisions about visits to family/friends
	Participation rate in decisions about what food to cook daily
	Prevalence of Female Genital Cutting
	Proportion that do not own house, ratio
	Unmet need for contraception, married women
World Bank GFI	Account at a financial institution, ratio
ILO	Unemployment rate, ratio
	Vulnerable employment (of employed), ratio
	Self employed (of employed), ratio
OECD	Wage gap (median wage)
UN	Infant mortality rate, ratio
	Under 5 mortality rate, ratio
UN Population Division	Adolescent fertility rate (15-19 yrs)
	Fertility rate

	Life expectancy ratio
	Male to female births ratio
UN Statistics Division	Women subjected to physical/sexual violence in last 12 months
UNAIDS	Access to antiretroviral drugs, ratio
	Prevalence of HIV, ratio
UNDP	Pregnant women w/ $\geq 4$ antenatal visits
UNESCO	Adult literacy rate (15+), ratio
UNICEF	Births attended by skilled health staff (of total births)
	Pregnant women receiving prenatal care
Woman Stats	Marital rape scale <sup>4</sup>
	Murder Scale 1 <sup>5</sup>
	Rape prevalence scale <sup>6</sup>
World Bank Gender Stats	Cannot come up with emergency funds, ratio
	Child mortality ratio
	Debit card in own name, ratio
	Long-term unemployment ratio
	Saved money in past year, ratio
	Received loan in past year, ratio
World Bank WBL	Legal age of marriage, ratio
	Maternity leave, days paid
	Maternity leave, pct. wages paid
	Mothers guaranteed equivalent position after maternity leave

<sup>4</sup>This is an ordinal coding of the officially reported rape prevalence per 100,000 people. 0:0, 1:1-10, 2:11-30, 3:31-60, 4:>60. See <http://www.womanstats.org/new/codebook/>

<sup>5</sup>This is an ordinal scale coded 0 to 2. It is “[d]esigned to scale the sanction of or pressure for female murder in a given state, examining cultural/social practices that condone murder and/or injuring of women. This includes murder as a result of accused witchcraft, elopement, suspicion of promiscuity, infidelity, rape, “honor” killings, religious or ethnic practices, dowry deaths, acid attacks, etc.” It is coded 0 where there is no evidence of such practices., 1 where there is some evidence of such practices, and 2 where there is substantial evidence of such practices.

<sup>6</sup>This is an ordinal scale coded 0 where sources indicate that marital rape is rare or infrequent, 1 where sources indicate that marital rape is not uncommon but by no means universal, and 2 where sources indicate that marital rape is a significant problem (high prevalence)



World Health Organization	Paternity leave, days paid
	Maternal mortality rate
	Prevalence of obesity, ratio
	Prevalence of severe wasting, ratio
	Prevalence of stunting, ratio
	Prevalence of underweight, ratio
	Smoking prevalence, ratio

Table 3: Observed Indicators for Women’s Rights Model

Source	Indicator
World Bank WBL	Civil remedies for sexual harassment exist
	Civil remedies for sexual harassment in employment exist
	Clear criminal penalties for domestic violence exist
	Constitutional clause on gender nondiscrimination in the constitution
	Criminal penalties for sexual harassment exist
	Criminal penalties for sexual harassment in employment exist
	Dismissal of pregnant workers is prohibited
	Domestic violence legislation covers economic violence
	Domestic violence legislation covers emotional violence
	Domestic violence legislation covers physical violence
	Domestic violence legislation covers sexual violence
	Domestic violence legislation exists
	Domestic violence legislation protects former spouses
	Domestic violence legislation protects unmarried partners
	Employers required to provide break for nursing mothers
	Female and male surviving spouses have equal rights to inherit assets
	Law mandates equal remuneration for females and males for work of equal value
	Law mandates nondiscrimination based on gender in hiring
	Law prohibits/invalidates child or early marriage
	Law provides for the valuation of non-monetary contributions
Legal age of marriage, ratio	

Legislation explicitly criminalizes marital rape

Legislation on domestic violence protects family members

Legislation on sexual harassment in education exists

Legislation on sexual harassment in employment exists

Legislation on sexual harassment in public places exist

Legislation specifically addresses sexual harassment

Married couples share legal responsibility for maintaining family expenses

Married men and women have equal ownership rights to property

Married women are required by law to obey their husbands

Married women can be head of household in same way as men

Married women can confer citizenship on her children in same way as men

Married women can confer citizenship to a non-national spouse in same way as men

Married women can choose where to live in same way as men

Married women can get a job/pursue a trade/profession in same way as men

Married women can obtain national ID card in same way as men

Married women can open bank account in same way as men

Married women can register a business in same way as men

Married women can sign a contract in same way as a man

Married women can travel outside their home

Married women can travel outside the country in same way as men

Nonpregnant women can do the same jobs as men

Nonpregnant women can work in jobs deemed arduous in same way as men

Nonpregnant women can work in jobs deemed morally inappropriate in same way as men

Nonpregnant women can work the same night hours as men

Penalties exist for authorizing/knowingly entering into child/early marriage

Protection orders for domestic violence exist

Protection orders prohibit/limit contact with survivor

Protection orders provide for removal of perpetrator from the home

Sons and daughters have equal rights to inherit assets

Specialized court or procedure exists for domestic violence

Unmarried men and women have equal ownership rights to property

Unmarried women can apply for passport in same way as men

Unmarried women can be head of household in same way as men

V Dem

Unmarried woman can choose where to live in same way as men  
Unmarried women can confer citizenship on her children in same way as men  
Unmarried women can obtain national ID card in same way as men  
Unmarried women can open a bank account in same way as men  
Unmarried women can register business in same way as men  
Unmarried women can sign a contract in same way as men  
Unmarried women can travel outside her home in same way as men  
Woman's testimony carries the same evidentiary weight in court as a man's  
Women's access to justice index  
Women's property rights index  
Women's suffrage (proportion eligible to vote)

---

---

## REFERENCES

- Bollen, Kenneth. 1989. *Structural Equations with Latent Variables*. Wiley.
- Caprioli, Mary, Valerie M Hudson, Rose McDermott, Bonnie Ballif-Spanvill, Chad F Emmett and S Matthew Stearmer. 2009. “The Womanstats Project database: Advancing an empirical research agenda.” *Journal of Peace Research* 46(6):839–851.
- Cingranelli, David L., David L. Richards and K. Chad Clay. 2014. “The Cingranelli-Richards (CIRI) Human Rights Dataset.”  
**URL:** <http://www.humanrightsdata.com>
- Coppedge, Michael, John Gerring, Staffan I. Lindberg, Svend-Erik Skaaning, Jan Teorell, David Altman, Michael Bernhard, M. Steven Fish, Adam Glynn, Allen Hicken, Carl Henrik Knutsen, Joshua Krusell, Anna Lührmann, Kyle L. Marquardt, Kelly McMann, Valeriya Mechkova, Moa Olin, Pamela Paxton, Daniel Pemstein, Josefine Pernes, Constanza Sanhueza Petrarca, Johannes von Römer, Laura Saxer, Brigitte Seim, Rachel Sigman, Jeffrey Staton, Natalia Stepanova and Steven Wilson. 2017. “V-Dem Country-Year Dataset v7.1.” Varieties of Democracy (V-Dem) Project.
- Demirgüç-Kunt, Asli, Leora F. Klapper, Dorothe Singer and Peter van Oudheusden. 2015. “The Global Findex Database 2014: Measuring Financial Inclusion Around the World.” World Bank Policy Research Working Paper No. 7255.  
**URL:** <https://ssrn.com/abstract=2594973>
- Gelman, Andrew and Donald B. Rubin. 1992. “Inference from Iterative Simulation Using Multiple Sequences.” *Statistical Science* 7(4):457–472.
- Karim, Sabrina and Daniel W. Hill Jr. 2018. “The Study of Gender and Women in Cross-National Political Science Research: Rethinking Concepts and Measurement.” Working Paper.
- UNDP. 1994. *Human Development Report*. New York: Oxford.