A Dynamic Ordinal Item Response Theory Model with Application to Human Rights Data

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Plan of the Talk

Goal

Convince you that we have constructed a more precise and more informative measure of human rights

A measure that you can use

Plan of the Talk

- Issues with human rights data
- Dynamic Ordinal Item Response Theory model (DO-IRT)
- A more precise measure of human rights
- Comparison to other measures
- How to apply the new measure in statistical models

Current Measures of Human Rights

5-point Political Terror Scale (Gibney, Cornett and Wood)

9-point CIRI Physical Integrity Scale (Cingranelli and Richards)

Both scales are coded from Human Rights Country reports published annually by the US State Dept. and Amnesty Intl.

Problems with Measuring Human Rights

Describing the World

How confident are we in the precision of the data for each country in each year?

Choosing one number ignores the uncertainty inherent in combining many pieces of information

Modeling the World

Estimation issues with modeling ordinal data

Motivation for the Model

Build on the earlier dynamic IRT models (Martin and Quinn, 2002) and ordered IRT models (Treier and Jackman, 2008)

Incorporate temporal information into estimates of latent variables using item response theory (IRT)

Let the posterior estimate of θ in year $t-1$ become the prior estimate for θ in year t

The Model

Priors

$$
\begin{aligned}
\theta_{t=1} &\sim \mathcal{N}(0,1) \\
\theta_{t>1} &\sim \mathcal{N}(\theta_{t-1},\sigma) \\
\sigma &\sim U(0,1) \\
\beta_j &\sim Gamma(4,3) \\
\tau_{j,K} &\sim Gamma(4,3)
\end{aligned}
$$

Ordinal CIRI Variables

Physical Integrity Rights

Right	*Explanation*
Disappearances	Lack of deliberate disappearances of citizens by the government
Extrajudicial Killing	Lack of political and other extrajudicial killings or unlawful depravation of life
Political Imprisonment	Lack of imprisonment because of religious, political or other beliefs
Torture	Lack of torture and other cruel, inhumane, or degrading treatment or punishment

Variable Assessment

What does θ look like?

Illustration of θ

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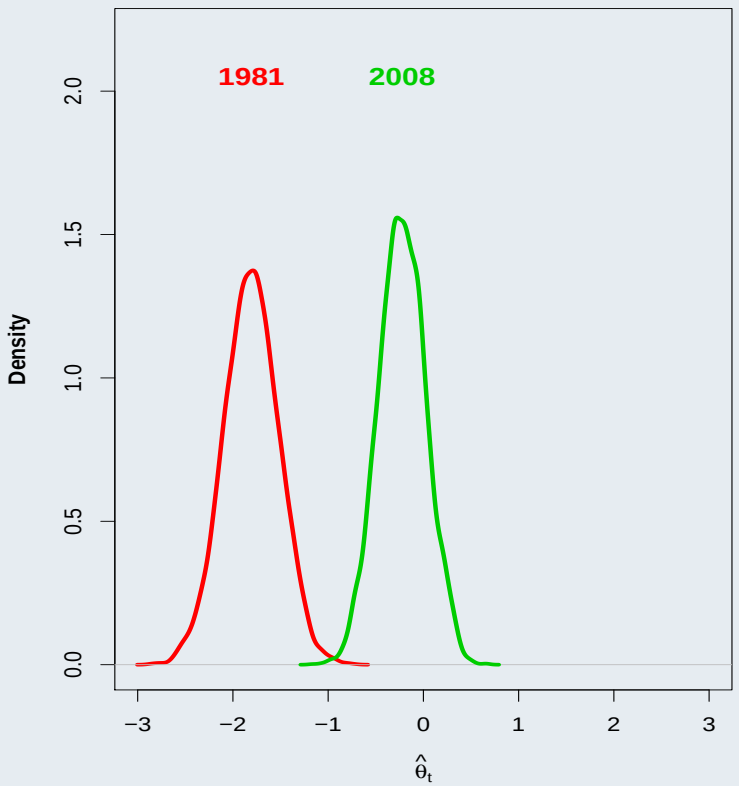
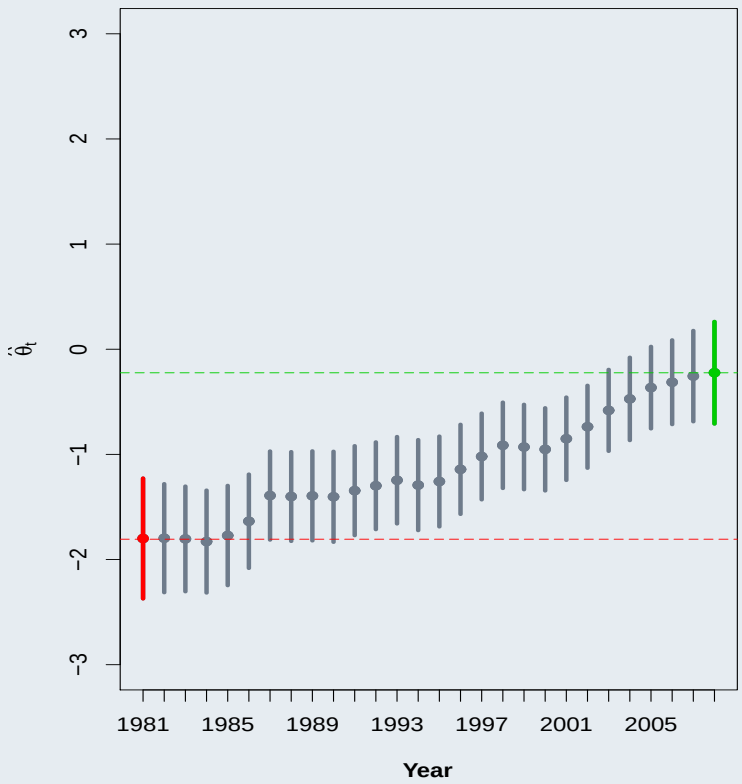
References

Guatemala Across Time





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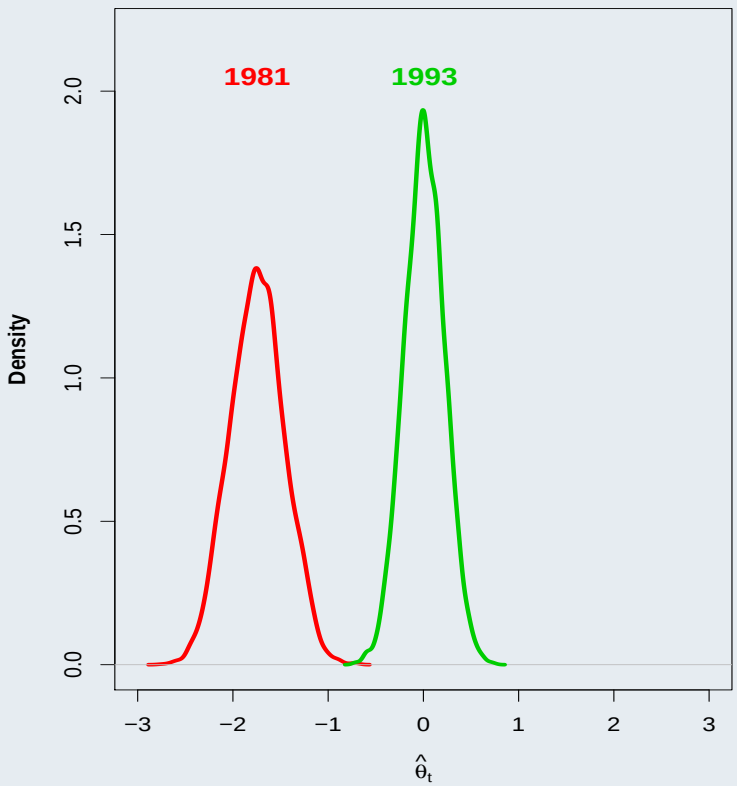
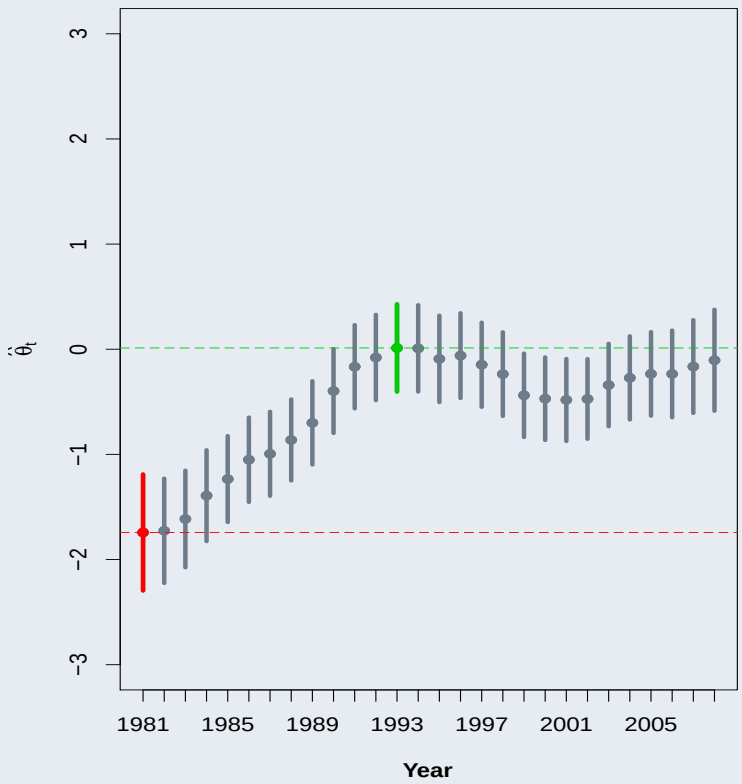
Namibia Across Time





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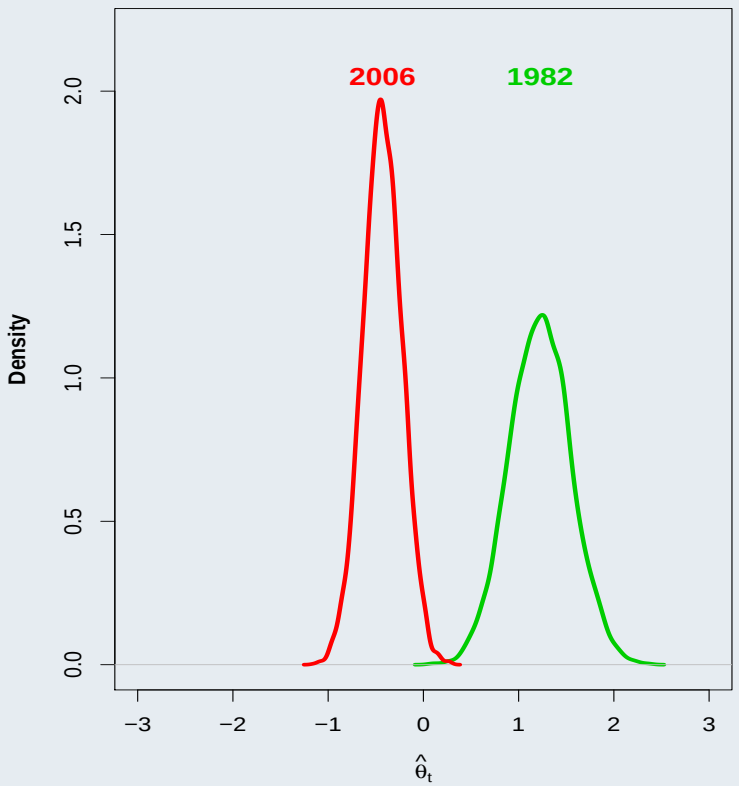
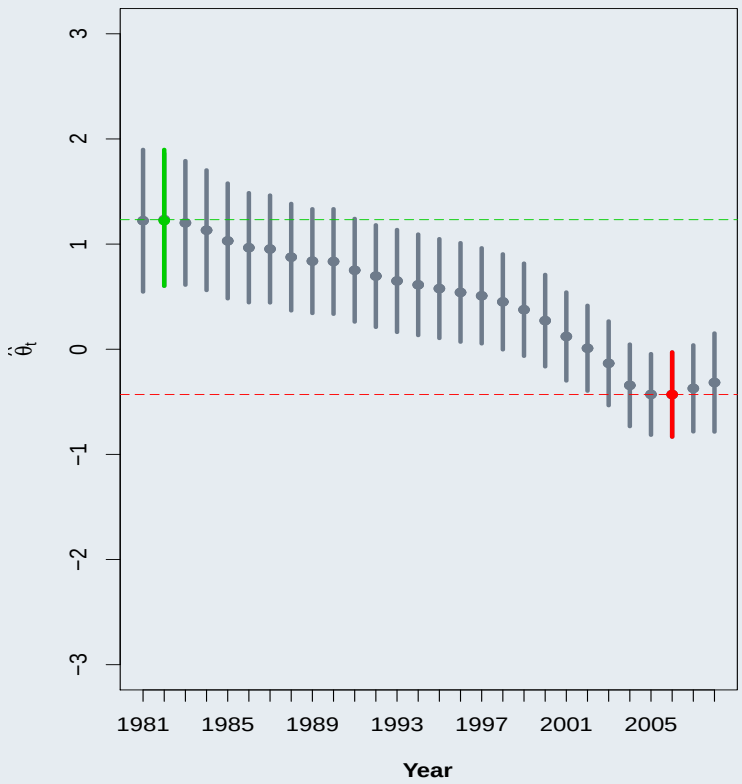
United States Across Time





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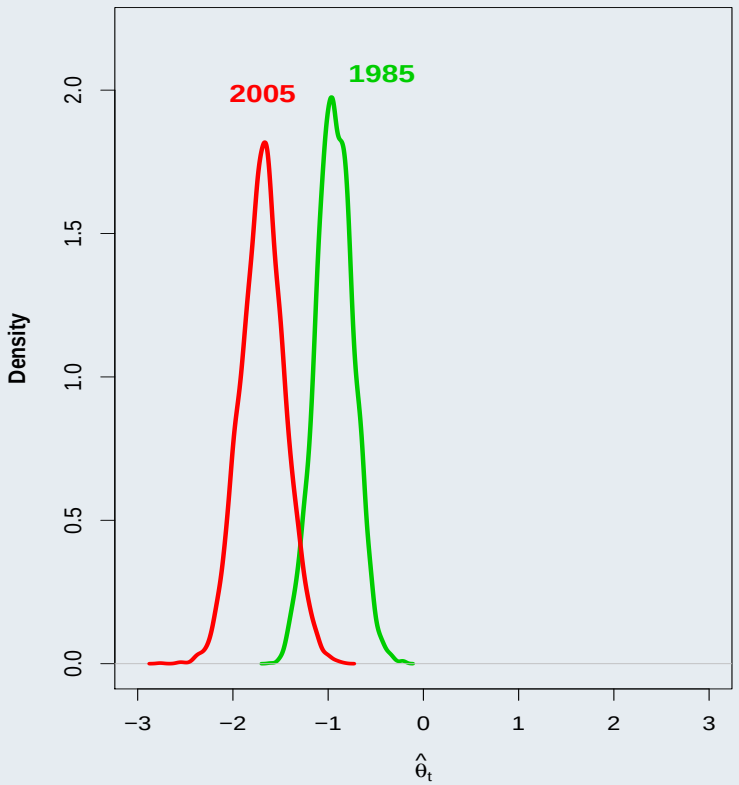
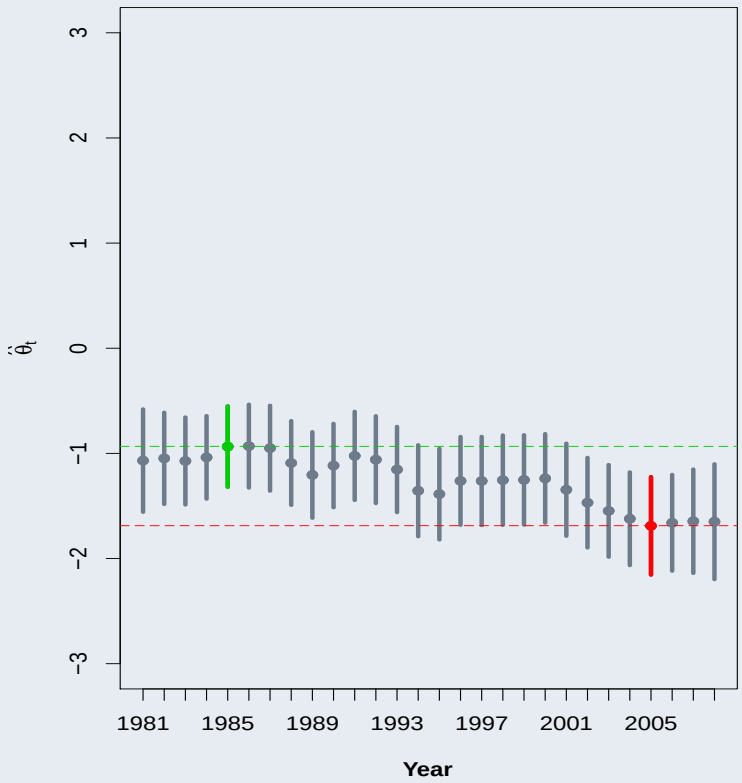
China Across Time





Variable Assessment

Convergent Validity

		1	2	3	4
1	Latent Physical Integrity	–	**0.899**	**0.783**	**0.838**
2	CIRI Physical Integrity Index	–	–	0.762	0.830
3	PTS Amnesty Index	–	–	–	0.800
4	PTS State Dept. Index	–	–	–	–

Variable Assessment

Discriminant Validity

		1	2	3	4
1	Latent Physical Integrity	–	**0.567**	**0.652**	**0.599**
2	CIRI Empowerment Index	–	–	0.955	0.810
3	Latent Empowerment	–	–	–	0.875
4	Democracy	–	–	–	–

Comparison of θ Across Cases

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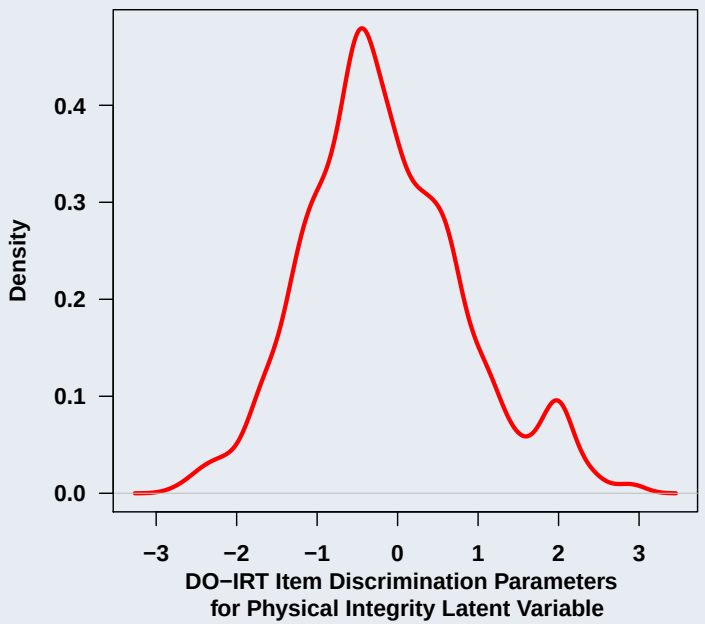

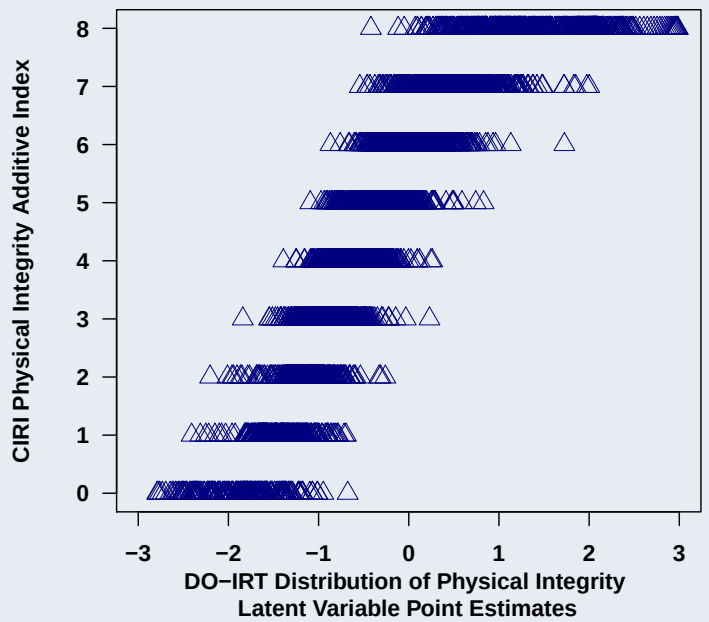

Applying the New Measure

As an independent variable (with uncertainty)

As a dependent variable

Applying the New Measure

Independent Variable with Uncertainty

Create $m = 10$ datasets with different draws from the distribution for each country-year θ

Estimate a statistical model for each dataset and combine inferences

The point estimate for each parameter is the mean from the m estimates, and the standard error is calculated using an equation developed by Rubin (1987)

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Applying the New Measure

Dependent Variable

Use the mean estimate of θ since the statistical model will account for measurement error in the dependent variable

Use OLS or any other estimator for panel data with a continuous dependent variable

Can forget about ordered-logit and ordered-probit

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Conclusion

Today's Talk

Dynamic Ordinal Item Response Theory model (DO-IRT)

A more precise measure of human rights

How to apply the new measure in statistical models as both and independent and dependent variable

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Conclusion

For More Information

`http://dss.ucsd.edu/ cfariss/HumanRightsScores`

How to guide is being written

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Thank you

Appendix: Rubin (1987) Standard Error Formula

$$\sqrt{\frac{1}{m}\sum_{k}^{m} s_k^2 \left(1+\frac{1}{m}\right)\sigma_\beta^2}$$

where s_k^2 is the standard error from dataset k, and σ_β^2 is the variance in the regression coefficients between datasets. In words, the standard error is the average standard error from each model, plus the variance in the regression coefficients times a correction factor for $m < \infty$.

Appendix: DO-IRT Model

Let $i = 1, \ldots, N$ index cross-sectional units and $t = 1, \ldots T$ index time periods.

In each time period observe values y_{ij} for each of $j = 1, \ldots, J$ indicators for each unit

Each indicator is ordinal in nature and can take on K_j values.

The responses to each of the items depends on a single latent variable $\theta_{i,t}$ which may vary across units and over time within each unit.

Appendix: DO-IRT Model

θ is a *unidimensional latent variable*

The model assumes *latent monotonicity*, which means that the item step response function is strictly increasing on θ; formally, $\theta_a \leq \theta_b$ implies that $Pr[X_{i,t,j} \geq x|\theta_a] \leq Pr[X_{i,t,j} \geq x|\theta_b]$.

The model assumes *local independence*, which means that the responses depend only on θ, $Pr[X_{i,t,1} = x_{i,t,1}, X_{i,t,2} = x_{i,2} \cdots X_{i,t,J} = x_{i,t,J}|\theta] = \prod_{j=1}^{J} Pr[X_{i,t,j} = x_{i,t,j}|\theta]$.

Appendix: DO-IRT Model

The probability distribution for a given response to item j is given by $P[y_{ij} = k] = F(\alpha_{j,k} - \theta_{it}\beta_j) - F(\alpha_{j,k} - \theta_{it}\beta_j)$

$F(\cdot)$ denotes the logistic cumulative distribution function.

Assuming local independence of responses across units, the likelihood function for β, α, and θ given the data is

$$\mathcal{L}(\beta, \alpha, \theta | y) = \prod_{i=1}^{N} \prod_{t=1}^{T} \prod_{j=1}^{J} \left[F(\alpha_{j,y_{ij}} - \theta_{it}\beta_j) - F(\alpha_{j,y_{ij}-1} - \theta_{it}\beta_j) \right].$$

Cingranelli, David L. and David L. Richards. 1999. "Measuring the Level, Pattern, and Sequence of Government Respect for Physical Integrity Rights." *International Studies Quarterly* 43(2):407–417.

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Rubin, Donald B. 1987. *Multiple Imputation for Nonresponse in Surveys*. New York, NY: J. Wiley Sons.

Treier, Shawn and Simon Jackman. 2008. "Democracy as a Latent Variable." *American Journal of Political Science* 52(1):201–217.