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Extremism does not stop at borders, and neither should our models

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Kunst et al. (1) use multilevel regression models to examine macrolevel predictors of violent extremist intentions (VEI) across 58 countries. Multilevel modeling assumes country-level residuals are independent, a claim hard to defend when countries share borders and institutions. Neighboring countries share security conditions, economic ties, and media environments, producing spatial correlation in country-level outcomes (2). When spatial dependence goes unmodeled, SE are biased, and coefficients can absorb or mask geographic clustering (3, 4).

We re-estimated the country-level analyses of Kunst et al. using a spatial Durbin model (SDM) via generalized spatial two-stage least squares with heteroskedastic errors (5). Moran's I tests on the multilevel model residuals confirm significant spatial autocorrelation (offensive VEI: Moran's I = 0.245, $P < 0.001$). We used Queen contiguity weights for spatial lags and inverse distance weights for error correlation; results hold under alternative specifications. Because the SDM includes predictor spatial lags (W × X), total effects decompose into direct and indirect components (6). We estimated the original Models 1 to 5, plus Model 6, which entered all six macropredictors simultaneously.

The Democracy Index finding holds up best. Its negative direct effect on offensive VEI (we use β for SDM coefficients throughout) survives spatial adjustment in every bivariate specification (Table 1) and is the only predictor that retains significance in Model 6 (β = −0.416, $P = 0.046$), though the total effect drops to marginal significance ($P = 0.069$; Table 2).

Other findings are less stable. The GTI effect on offensive VEI, reported as significant by Kunst et al. (γ = 0.06, $P = 0.015$), drops to nonsignificance in the SDM (β = 0.043, $P = 0.575$). The bivariate GTI model fails the Wald test ($\chi^2 = 0.34$, $P = 0.953$), suggesting the apparent association reflects geographic clustering rather than a direct relationship.

The SDM also reveals what the multilevel model hides. GTI becomes a significant predictor of defensive VEI in Model 6 (β = −0.196, $P = 0.001$), a suppression effect that surfaces only after spatial confounds are controlled, perhaps because populations exposed to terrorism adopt protective rather than offensive orientations. Cross-border spillovers appear as well: neighboring-country GDP per capita (W × GDP: β = −0.427, $P = 0.005$) and GINI inequality (W × GINI: β = −0.205, $P = 0.037$) both predict lower offensive VEI, even though own-country GINI shows no direct association, suggesting that relative deprivation operates across borders. Both spillovers persist in Model 6 (Table 2).

We acknowledge two limitations. We reanalyzed all six country-level predictors from Kunst et al., a natural starting point for a direct replication but one that lacks independent justification, rather than preregistering a spatial model or selecting from a standardized indicator set; future replications should prespecify variable selection. Nevertheless, spatial dependence is the rule rather than the exception in cross-national data. Multilevel models handle individual-country nesting well but are blind to spatial correlation at the country level, which can inflate, suppress, or fabricate associations between macroindicators and outcomes.

Table 1. Multi-level regression vs. spatial Durbin model for offensive VEI

		Multilevel regression		Spatial Durbin model	
Model	Predictor	γ	*P*	β	*P*
Model 1	Global Terrorism Index (GTI)	0.06	0.015	0.043	0.575
Model 2	Global Peace Index (GPI)	0.08	0.185	0.161	0.011
Model 3	Democracy Index	−0.18	<0.001	−0.305	<0.001
Model 4	Human Development Index (HDI)	−2.15	<0.001	−0.200	0.010
Model 5	GDP per Capita	−0.15	0.023	−0.171	0.014
	GINI index	-0.08	0.212	−0.032	0.497

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Table 2. Spatial Durbin model for Model 6 (all predictors)

Predictor	Direct effect	*P*	Indirect effect	*P*	Total effect	*P*
Global Terrorism Index (GTI)	−0.023	0.693	−0.138	0.083	−0.160	0.079
Global Peace Index (GPI)	−0.018	0.763	0.034	0.731	0.016	0.895
Democracy Index	−0.417	0.048	0.022	0.864	−0.395	0.069
Human Development Index (HDI)	−0.015	0.922	−0.224	0.233	−0.239	0.032
GINI index	−0.010	0.873	−0.103	0.030	−0.114	0.015
GDP per Capita	0.131	0.195	−0.020	0.871	0.111	0.441

Note: Impact decomposition for offensive VEI (N = 56, Pseudo R^2 = 0.513, Wald P < 0.001).

1. J. R. Kunst *et al.*, The psychology of offensive and defensive intergroup violence: Preregistered insights from 58 countries. *Proc. Natl. Acad. Sci. U.S.A.* **123**, e2535665123 (2026).
2. L. Anselin, Spatial externalities, spatial multipliers, and spatial econometrics. *Int. Reg. Sci. Rev.* **26**, 153–166 (2003).
3. D. Gruda, P. Hanges, J. McCleskey, Mirror, mirror on the wall, who's the healthiest of them all–The surprising role of narcissism in state-level health outcomes. *J. Res. Pers.* **109**, 104465 (2024).
4. D. Gruda, R. Gonçalves, M. Sharafi Zadegan, Quit playing games with our lives: Layoffs predict road traffic fatalities. *Accid. Anal. Prev.* **224**, 108302 (2026).
5. H. H. Kelejian, I. R. Prucha, A generalized spatial two-stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances. *J. Real Estate Fin. Econ.* **17**, 99–121 (1998).
6. J. LeSage, R. K. Pace, *Introduction to Spatial Econometrics* (Chapman and Hall/CRC, 2009).