ONLINE APPENDIX

A. Articles from literature search

Candidate articles were generated from a boolean search on Google Scholar for articles appearing in the APSR, AJPS, JOP, IO, and BJPS using the following terms: instrumental variable, instrumental variables, 2SLS, stage least squares, and TSLS. The authors then reviewed all returns to determine the articles that used spatial instruments – e.g., other unit realizations of the the endogenous predictor. Not only are these articles often high impact (as noted by the cite counts), but they also are increasing in usage over time – the frequency of articles per year and a time trend are correlated at 0.51. Moreover, this is a partial list with many additional uses of spatial instruments appearing in prominent subfield journals in comparative politics and international relations – JCR, JPR, ISQ, and CPS – where the use of spatial instruments has been the most common (Mansfield, 1998; Kerner, 2009; Cammett and Malesky, 2012; Berrebi and Ostwald, 2014, etc.).

Table 1: Articles in APSR, AJPS, JOP, IO, BJPS using spatial instruments, 2004-2016

Author(s)	Year	Journal	Citation Count
MacCulloch	2004	AJPS	53
Stasavage	2005	AJPS	400
Cheibub	2005	APSR	80
Pop-Eleches	2007	JOP	176
Colaresi	2007	IO	35
Searing et al.	2007	BJPS	32
Huckfeldt and Mendez	2008	JOP	74
Ansell	2008	IO	63
Kucik and Reinhardt	2008	IO	116
Buethe and Milner	2008	AJPS	551
Boix	2011	APSR	161
Simpser and Donno	2012	JOP	39
Baccini and Urpelainen	2012	JOP	15
Tyburski	2014	JOP	4
Albertus, Menaldo et al.	2014	BJPS	43
McDonald	2015	IO	11
Cole	2015	IO	6
Johns and Pelc	2015	JOP	1
Rozenas	2016	JOP	3
Knutsen et al.	2016	AJPS	1
Girod and Tobin	2016	IO	12
Ballard-Rosa, Carnegie and Gaikwad	2016	BJPS	1
Pérez-Liñán and Castagnola	2016	BJPS	1

B. Simulations

For the simulations, we generate data sets of 400 observations as follows,

$$y_i = \beta x_i + \rho_y \sum_{j \neq i} y_j + \rho_x \sum_{j \neq i} x_j + e_i, \tag{1}$$

$$x_i = \gamma z_i + u_i, \tag{2}$$

where $\beta = 1$ is the true coefficient and the parameter of interest. e_i and u_i are drawn from a multivariate normal, with mean zero and correlations from zero to one, depending on the specification.

In short, we created the remaining variables as follows:

1. For 2SLS with i.i.d. instruments, we draw z_i from a normal distribution with mean zero and variance one. We set ρ_y and ρ_x both to zero, and $\gamma = 1$ (which ensures a 'strong' instrument by common measures of instrument strength).

2. For 2SLS with a spatial instrument, we create a matrix $\mathbf{W}$ such that eight regions of fifty observations each are created. Within each region, the instrument z_i is constructed as the region average of $x_{j \neq i}$, such that $\mathbf{x} = \text{inv}(\mathbf{I} - \rho \mathbf{W})\mathbf{u}$, where $\rho = .5$ (which ensures a 'strong' instrument by common measures of instrument strength) and $\mathbf{I}$ is the 400x400 identity matrix. We set ρ_y and ρ_x both to zero.

3. For 2SLS with a spatial instrument and outcome interdependence, we create a spatial instrument as in point 2. We set $\rho_x = 0$ and $\rho_y = .2$, using the same weight matrix.

4. For 2SLS with a spatial instrument and spillovers, we create a spatial instrument as in point 2. We set $\rho_y = 0$ and $\rho_x = .2$.

We create 1,000 data sets to obtain coefficient estimates of β and report, in Figure 1, the median bias of the 2SLS estimate of β as a function of $\text{corr}(e, u)$.

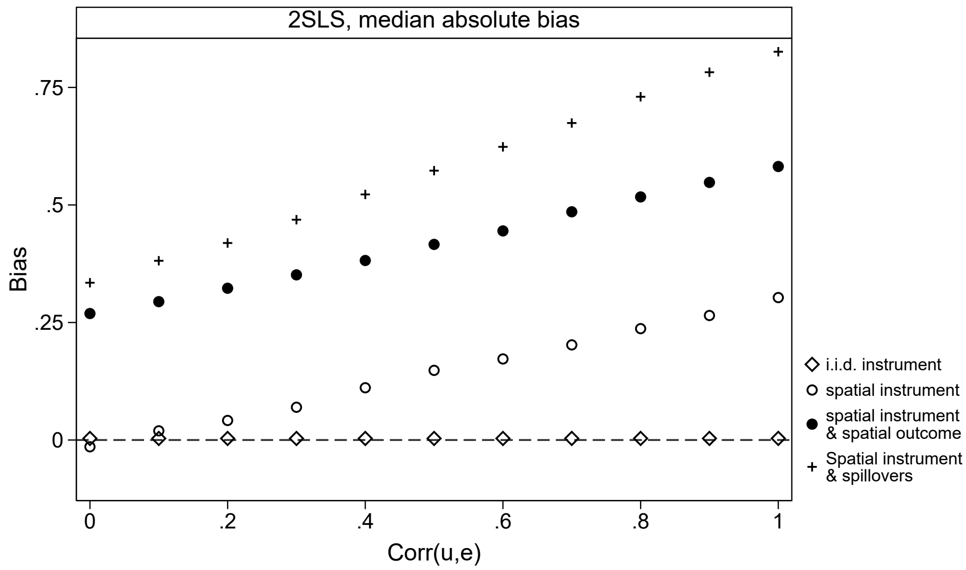

Figure 1: MC simulations – 2SLS median absolute bias with i.i.d. instrument; spatial instrument; spatial instrument and outcome interdependence; and spatial instrument and spillovers.

Figure 1 briefly demonstrates the bias discussed analytically in the main text. The endogeneity of the predictor (i.e., $\mathrm{corr}(u, e)$) increases along the x-axis. In the absence of spillovers and outcome interdependence, 2SLS yields unbiased results when using an i.i.d. instrument (diamonds). By contrast, with a spatial instrument (hollow circles), 2SLS is biased. The bias increases further in the presence of outcome interdependence (filled circles) and is larger still given spillovers (crosses). Importantly, even when no spillovers exist and the outcomes are independent – the best case scenario – spatial instruments create substantial bias. This bias increases in the endogeneity of the variable of interest, as this also increases the correlation between the spatial instrument and the outcome disturbance due to simultaneity. Spatial instruments produce the worst results when they are needed most.

C. Illustration

As our discussion in the main text notes, when spillovers and interdependence cannot be eliminated, spatial instruments should not be pursued. Where these can be ruled out, however, it is possible to devise strategies that yield asymptotically unbiased estimates with spatial instruments. For example, estimating the first stage non-linearly and using the predicted values as instruments in 2SLS (or, more efficiently, relying on full-information maximum likelihood), addresses the spatial simultaneity in the projection of the endogenous variable on the instrument. To illustrate, Table 2 replicates a result from Flores-Macías and Kreps (2013), which argues that dependence on trade with China makes states more likely to support Chinese foreign policy preferences. Their analysis includes models where energy production is employed as an instrument for trade with China, which for the purposes of our subsequent discussion we accept as a valid instrument.

Column 1 replicates the key result from Flores-Macías and Kreps (2013): logged trade with China, instrumented by energy production, increases the similarity between a country's and China's UN General Assembly votes on human rights issues. In column 2, we replace the instrument with a spatial instrument: the logged sample average of annual trade with China. The 2SLS coefficient estimate increases markedly compared to the original estimate from Flores-Macías and Kreps (2013). If the original estimate is accepted as valid, using a spatial instrument induces upwards bias of about 30 percent into the coefficient estimate. In column 3, we address the spatial simultaneity by estimating a non-linear first stage via maximum likelihood. We then estimate a 2SLS model, using the predicted values from the first stage as instruments for the endogenous variable. The resulting coefficient is i) smaller than in model 2, indicating the possible inflationary bias from simultaneity and ii) closer to the original estimate from Flores-Macías and Kreps (2013) in model 1.

Yet, this approach has two drawbacks that dissuade us from advocating it more fully. First, it still requires ruling out spillovers and interdependence, which, we have argued, is often challenging. When present, the resulting estimates are biased. Second, the fitness of the estimator is contingent on the accurate specification of the data-generating process for the endogenous pre-

Table 2: Similarity in UN Human Right Votes and Trade with China

	(1) Original z 2SLS	(2) Spatial z 2SLS	(3) Spatial $\hat{z}$ ML & 2SLS
Trade Flows	.046***	.060***	.051***
	(.013)	(.008)	(.009)
National Capability	.24***	.24***	.24***
	(.066)	(.069)	(.067)
US Aid/GDP	-.025***	-.026**	-.025**
	(.010)	(.011)	(.010)
US Trade	.007	-.003	.004
	(.015)	(.014)	(.013)
Regime	.052**	.058**	.054**
	(.025)	(.025)	(.025)
Human Rights	-.006	-.006	-.006
	(.009)	(.010)	(.010)
Post-2003	-.16***	-.18***	-.17***
	(.027)	(.020)	(.021)
Constant	1.37***	1.35***	1.36***
	(.349)	(.367)	(.354)
Number Obs.	592	592	592
First stage t-statistic	7.32	17.77	14.32
Number Obs.	592	592	592
Country FE	yes	yes	yes

Column (1): Flores-Macías and Kreps (2013) specification, instrument: energy production. Column (2): instrument: logged sample average of trade flows. Column (3): instrument: predicted trade flows from spatial ML.

dictor. This requires correctly specifying the nature of the spatial dependence in the endogenous predictor, which others have noted can be challenging. The need to accurately characterize the first stage is in stark contrast to standard IV estimators such as 2SLS, which are attractive in part because they are robust to misspecification in the first stage. As such, the convenience of spatial instruments comes the cost of additional untestable and possibly untenable assumptions.

First stage results application

Table 3: First stage results

	(1) original z OLS	(2) spatial z OLS	(3) spatial z OLS
Energy production	2.38***		
original instrument	(.325)		
Average trade		.95***	
spatial instrument		(.054)	
Predicted trade			2.78***
from spatial ML			(.194)
National Capability	-.27	-.81	1.59**
	(.666)	(.555)	(.625)
US Aid/GDP	.017	.23*	-.36**
	(.148)	(.128)	(.158)
US Trade	.49***	.14	-.22*
	(.128)	(.101)	(.128)
Regime	-.24	-.050	.21
	(.218)	(.175)	(.216)
Human Rights	-.073	.019	-.069
	(.103)	(.089)	(.100)
Post-2003	1.37***	.11	-3.64***
	(.104)	(.119)	(.377)
Constant	-24.7***	-4.66	-1.13
	(5.117)	(2.929)	(3.282)
Number Obs.	592	592	592
Country FE	yes	yes	yes

Dependent variable: log trade with China. Coefficient estimates and robust standard errors. Data from Flores-Macías and Kreps (2013).

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