Appendix:
Recouping after Coup-Proofing: Compromised Military Effectiveness and Strategic Substitution

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February 12, 2015

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Contents

1 Introduction to the Appendix

The supplementary material presented in this document provides additional details about the analyses presented in the paper "Recouping after Coup-Proofing: Compromised Military Effectiveness and Strategic Substitution". The main document makes reference to the materials contained here. Replication materials are available here:

`http://thedata.harvard.edu/dvn/dv/internationalinteractions`

2 Bayesian Negative Binomial Regression of Substitution with Allies

The following models replicate the negative binomial regression found the in the manuscript using Bayesian statistical software. The purpose of these replications is to show that the results are consistent when using Bayesian estimation and to then estimate alternative versions of these models in which we drop the lagged dependent variable and add multiple intercepts, which are specified to vary over time. Overall, the results are consistent yet stronger than those reported in the main manuscript of the paper.

Two key differences stand out between the models presented here and those in the main paper. First, the interaction term between the two coup-proofing variables is not statistically different than 0 in the varying intercept model. Second, the results from the Bayesian models for the Effective Number (*ln*) are all probabilistically different than 0 though some of these coefficients had larger p-values than conventionally recognized as being distinct from 0 in the main paper. The coefficients for the key independent variables in the varying intercept model are about twice the size as the same coefficients in the model with the lagged dependent variable. The tables below present the lagged dependent variable version then the time varying intercept version for each of the 4 models contained in the main manuscript.

2.1 Model 1

Table 1: Bayesian Negative Binomial Regression of Substitution with Allies (Model 1 lagged DV)

Variable	β (S.D.)	95% CI
Effective Number, ln	0.071 (0.032)	[0.009 , 0.135]
Minority Regime		
E.N., ln $\times$ Min. Reg.		
Rivals' Strength	-0.034 (0.009)	[-0.050 , -0.017]
Polity2	-0.038 (0.002)	[-0.042 , -0.034]
OIL	-0.005 (0.030)	[-0.066 , 0.051]
CINC	-7.455 (0.667)	[-8.774 , -6.192]
Mountainous Terrain, ln	-0.122 (0.009)	[-0.141 , -0.105]
Middle East	0.243 (0.037)	[0.170 , 0.313]
Ally of the United States	-0.003 (0.044)	[-0.090 , 0.082]
Ally of Great Britain	0.281 (0.057)	[0.173 , 0.395]
Ally of Russia/USSR	0.400 (0.036)	[0.330 , 0.471]
Ally of France	0.782 (0.052)	[0.685 , 0.885]
Ally of China	0.577 (0.087)	[0.414 , 0.750]
Defense Pacts$_{t-1}$	0.128 (0.002)	[0.125 , 0.132]
Intercept	0.251 (0.033)	[0.186 , 0.312]
Rate	3.889 (0.195)	[3.526 , 4.276]

Table 2: Bayesian Negative Binomial Regression of Substitution with Allies (Model 1 varying intercepts)

Variable	β (S.D.)	95% CI
Effective Number, ln	0.175 (0.066)	[0.043 , 0.300]
Minority Regime		
E.N., ln × Min. Reg.		
Rivals' Strength	-0.067 (0.017)	[-0.099 , -0.034]
Polity2	-0.051 (0.004)	[-0.060 , -0.043]
OIL	0.028 (0.064)	[-0.094 , 0.155]
CINC	16.031 (1.050)	[14.015 , 18.094]
Mountainous Terrain, ln	-0.195 (0.019)	[-0.232 , -0.159]
Middle East	1.639 (0.075)	[1.492 , 1.784]
Ally of the United States	2.484 (0.069)	[2.347 , 2.623]
Ally of Great Britain	-0.131 (0.131)	[-0.396 , 0.133]
Ally of Russia/USSR	0.238 (0.069)	[0.103 , 0.378]
Ally of France	0.265 (0.116)	[0.039 , 0.496]
Ally of China	0.025 (0.174)	[-0.310 , 0.374]
Rate	0.605 (0.018)	[0.570 , 0.640]
$Intercept_{1970}$	0.590 (0.110)	[0.369 , 0.799]
$Intercept_{1971}$	0.594 (0.102)	[0.399 , 0.797]
$Intercept_{1972}$	0.617 (0.096)	[0.428 , 0.800]
$Intercept_{1973}$	0.638 (0.095)	[0.455 , 0.821]
$Intercept_{1974}$	0.672 (0.090)	[0.497 , 0.848]
$Intercept_{1975}$	0.684 (0.090)	[0.497 , 0.855]
$Intercept_{1976}$	0.704 (0.089)	[0.530 , 0.881]
$Intercept_{1977}$	0.753 (0.086)	[0.580 , 0.919]
$Intercept_{1978}$	0.802 (0.087)	[0.631 , 0.972]
$Intercept_{1979}$	0.860 (0.085)	[0.691 , 1.029]
$Intercept_{1981}$	0.930 (0.084)	[0.764 , 1.091]
$Intercept_{1982}$	1.047 (0.080)	[0.889 , 1.206]
$Intercept_{1983}$	1.118 (0.082)	[0.958 , 1.273]
$Intercept_{1984}$	1.155 (0.081)	[0.997 , 1.318]
$Intercept_{1985}$	1.170 (0.081)	[1.016 , 1.329]
$Intercept_{1986}$	1.178 (0.082)	[1.020 , 1.336]
$Intercept_{1987}$	1.185 (0.083)	[1.028 , 1.349]
$Intercept_{1988}$	1.195 (0.082)	[1.036 , 1.353]
$Intercept_{1989}$	1.217 (0.084)	[1.052 , 1.375]
$Intercept_{1990}$	1.247 (0.084)	[1.072 , 1.407]
$Intercept_{1991}$	1.289 (0.082)	[1.129 , 1.453]
$Intercept_{1992}$	1.306 (0.080)	[1.147 , 1.455]
$Intercept_{1993}$	1.317 (0.078)	[1.164 , 1.471]
$Intercept_{1994}$	1.349 (0.078)	[1.200 , 1.503]
$Intercept_{1995}$	1.356 (0.080)	[1.197 , 1.515]
$Intercept_{1996}$	1.361 (0.080)	[1.201 , 1.518]
$Intercept_{1997}$	1.376 (0.080)	[1.220 , 1.533]
$Intercept_{1998}$	1.418 (0.080)	[1.266 , 1.573]
$Intercept_{1999}$	1.444 (0.081)	[1.290 , 1.600]
$Intercept_{2000}$	1.460 (0.078)	[1.307 , 1.611]
$Intercept_{2001}$	1.520 (0.082)	[1.366 , 1.688]
$Intercept_{2002}$	1.536 (0.094)	[1.356 , 1.723]
$\sigma_{Intercept}$	0.007 (0.004)	[0.003 , 0.016]

2.2 Model 2

Table 3: Bayesian Negative Binomial Regression of Substitution with Allies (Model 2 lagged DV)

Variable	β (S.D.)	95% CI
Effective Number, ln		
Minority Regime	0.114 (0.033)	[0.050 , 0.176]
E.N., ln $\times$ Min. Reg.		
Rivals' Strength	-0.041 (0.009)	[-0.058 , -0.024]
Polity2	-0.037 (0.002)	[-0.041 , -0.033]
OIL	-0.010 (0.030)	[-0.068 , 0.049]
CINC	-7.315 (0.659)	[-8.600 , -6.046]
Mountainous Terrain, ln	-0.119 (0.009)	[-0.137 , -0.101]
Middle East	0.237 (0.037)	[0.165 , 0.308]
Ally of the United States	-0.003 (0.045)	[-0.094 , 0.086]
Ally of Great Britain	0.284 (0.058)	[0.171 , 0.398]
Ally of Russia/USSR	0.407 (0.037)	[0.337 , 0.479]
Ally of France	0.785 (0.055)	[0.678 , 0.893]
Ally of China	0.600 (0.088)	[0.428 , 0.765]
Defense Pacts$_{t-1}$	0.128 (0.002)	[0.124 , 0.132]
Intercept	0.269 (0.031)	[0.208 , 0.330]
Rate	3.908 (0.193)	[3.540 , 4.296]

Table 4: Bayesian Negative Binomial Regression of Substitution with Allies (Model 2 varying intercepts)

Variable	β (S.D.)	95% CI
Effective Number, ln		
Minority Regime	0.229 (0.068)	[0.098, 0.357]
E.N., ln × Min. Reg.		
Rivals' Strength	-0.080 (0.017)	[-0.113 , -0.046]
Polity2	-0.050 (0.004)	[-0.058 , -0.041]
OIL	0.002 (0.063)	[-0.121 , 0.119]
CINC	16.173 (1.059)	[14.122 , 18.326]
Mountainous Terrain, ln	-0.188 (0.018)	[-0.222 , -0.152]
Middle East	1.629 (0.074)	[1.478 , 1.766]
Ally of the United States	2.483 (0.068)	[2.350 , 2.612]
Ally of Great Britain	-0.147 (0.130)	[-0.399 , 0.103]
Ally of Russia/USSR	0.265 (0.068)	[0.131 , 0.397]
Ally of France	0.302 (0.119)	[0.064 , 0.533]
Ally of China	0.086 (0.169)	[-0.238 , 0.423]
Rate	0.607 (0.018)	[0.571 , 0.642]
Intercept_{1970}	0.627 (0.108)	[0.412 , 0.847]
Intercept_{1971}	0.628 (0.101)	[0.424 , 0.827]
Intercept_{1972}	0.649 (0.095)	[0.470 , 0.843]
Intercept_{1973}	0.676 (0.091)	[0.499 , 0.862]
Intercept_{1974}	0.710 (0.090)	[0.537 , 0.887]
Intercept_{1975}	0.720 (0.090)	[0.538 , 0.898]
Intercept_{1976}	0.741 (0.091)	[0.559 , 0.914]
Intercept_{1977}	0.786 (0.087)	[0.613 , 0.951]
Intercept_{1978}	0.831 (0.086)	[0.661 , 0.999]
Intercept_{1979}	0.891 (0.085)	[0.729 , 1.060]
Intercept_{1981}	0.958 (0.084)	[0.793 , 1.125]
Intercept_{1982}	1.078 (0.081)	[0.926 , 1.244]
Intercept_{1983}	1.150 (0.082)	[0.993 , 1.315]
Intercept_{1984}	1.189 (0.080)	[1.037 , 1.348]
Intercept_{1985}	1.213 (0.078)	[1.064 , 1.362]
Intercept_{1986}	1.233 (0.080)	[1.073 , 1.389]
Intercept_{1987}	1.247 (0.077)	[1.100 , 1.401]
Intercept_{1988}	1.259 (0.078)	[1.109 , 1.408]
Intercept_{1989}	1.275 (0.078)	[1.124 , 1.425]
Intercept_{1990}	1.308 (0.078)	[1.156 , 1.463]
Intercept_{1991}	1.349 (0.077)	[1.194 , 1.499]
Intercept_{1992}	1.368 (0.077)	[1.220 , 1.523]
Intercept_{1993}	1.376 (0.077)	[1.228 , 1.528]
Intercept_{1994}	1.406 (0.077)	[1.258 , 1.559]
Intercept_{1995}	1.408 (0.076)	[1.264 , 1.559]
Intercept_{1996}	1.411 (0.075)	[1.268 , 1.570]
Intercept_{1997}	1.425 (0.074)	[1.282 , 1.571]
Intercept_{1998}	1.465 (0.073)	[1.324 , 1.612]
Intercept_{1999}	1.491 (0.078)	[1.338 , 1.643]
Intercept_{2000}	1.511 (0.077)	[1.358 , 1.660]
Intercept_{2001}	1.564 (0.079)	[1.409 , 1.719]
Intercept_{2002}	1.580 (0.088)	[1.403 , 1.763]
$\sigma_{Intercept}$	0.007 (0.004)	[0.003 , 0.016]

2.3 Model 3

Table 5: Bayesian Negative Binomial Regression of Substitution with Allies (Model 3 lagged DV)

Variable	β (S.D.)	95% CI
Effective Number, ln	0.070 (0.033)	[0.007 , 0.133]
Minority Regime	0.115 (0.033)	[0.051 , 0.180]
E.N., ln $\times$ Min. Reg.		
Rivals' Strength	-0.038 (0.009)	[-0.056 , -0.021]
Polity2	-0.037 (0.002)	[-0.041 , -0.033]
OIL	-0.011 (0.031)	[-0.073 , 0.049]
CINC	-7.389 (0.659)	[-8.661 , -6.101]
Mountainous Terrain, ln	-0.122 (0.009)	[-0.140 , -0.104]
Middle East	0.241 (0.037)	[0.169 , 0.317]
Ally of the United States	0.008 (0.046)	[-0.082 , 0.095]
Ally of Great Britain	0.278 (0.055)	[0.168 , 0.388]
Ally of Russia/USSR	0.404 (0.037)	[0.331 , 0.478]
Ally of France	0.790 (0.054)	[0.686 , 0.896]
Ally of China	0.590 (0.087)	[0.416 , 0.757]
Defense Pacts$_{t-1}$	0.128 (0.002)	[0.124 , 0.132]
Intercept	0.241 (0.034)	[0.173 , 0.305]
Rate	3.922 (0.196)	[3.547 , 4.318]

Table 6: Bayesian Negative Binomial Regression of Substitution with Allies (Model 3 varying intercepts)

Variable	β (S.D.)	95% CI
Effective Number, ln	0.174 (0.065)	[0.045 , 0.300]
Minority Regime	0.229 (0.067)	[0.099 , 0.358]
E.N., ln × Min. Reg.		
Rivals' Strength	-0.073 (0.017)	[-0.107 , -0.039]
Polity2	-0.049 (0.004)	[-0.058 , -0.041]
OIL	0.006 (0.065)	[-0.123 , 0.132]
CINC	15.963 (1.048)	[13.959 , 18.010]
Mountainous Terrain, ln	-0.196 (0.019)	[-0.231 , -0.160]
Middle East	1.630 (0.077)	[1.487 , 1.784]
Ally of the United States	2.485 (0.067)	[2.353 , 2.614]
Ally of Great Britain	-0.154 (0.135)	[-0.408 , 0.118]
Ally of Russia/USSR	0.258 (0.072)	[0.125 , 0.395]
Ally of France	0.317 (0.122)	[0.069 , 0.546]
Ally of China	0.067 (0.168)	[-0.255 , 0.400]
Rate	0.607 (0.018)	[0.572 , 0.641]
Intercept_{1970}	0.563 (0.113)	[0.347 , 0.791]
Intercept_{1971}	0.571 (0.102)	[0.375 , 0.773]
Intercept_{1972}	0.591 (0.098)	[0.396 , 0.782]
Intercept_{1973}	0.619 (0.094)	[0.437 , 0.797]
Intercept_{1974}	0.654 (0.092)	[0.486 , 0.831]
Intercept_{1975}	0.668 (0.091)	[0.490 , 0.843]
Intercept_{1976}	0.692 (0.090)	[0.515 , 0.864]
Intercept_{1977}	0.737 (0.088)	[0.568 , 0.913]
Intercept_{1978}	0.783 (0.087)	[0.617 , 0.953]
Intercept_{1979}	0.840 (0.088)	[0.671 , 1.010]
Intercept_{1981}	0.907 (0.086)	[0.732 , 1.070]
Intercept_{1982}	1.025 (0.082)	[0.864 , 1.185]
Intercept_{1983}	1.097 (0.083)	[0.937 , 1.266]
Intercept_{1984}	1.131 (0.083)	[0.980 , 1.299]
Intercept_{1985}	1.146 (0.081)	[0.993 , 1.307]
Intercept_{1986}	1.152 (0.085)	[0.991 , 1.313]
Intercept_{1987}	1.162 (0.084)	[0.999 , 1.322]
Intercept_{1988}	1.172 (0.086)	[1.007 , 1.342]
Intercept_{1989}	1.192 (0.085)	[1.031 , 1.359]
Intercept_{1990}	1.223 (0.084)	[1.057 , 1.384]
Intercept_{1991}	1.263 (0.083)	[1.101 , 1.422]
Intercept_{1992}	1.284 (0.082)	[1.128 , 1.443]
Intercept_{1993}	1.291 (0.082)	[1.133 , 1.455]
Intercept_{1994}	1.324 (0.080)	[1.173 , 1.478]
Intercept_{1995}	1.328 (0.082)	[1.167 , 1.484]
Intercept_{1996}	1.329 (0.082)	[1.172 , 1.492]
Intercept_{1997}	1.342 (0.080)	[1.182 , 1.493]
Intercept_{1998}	1.382 (0.079)	[1.227 , 1.536]
Intercept_{1999}	1.406 (0.081)	[1.248 , 1.572]
Intercept_{2000}	1.426 (0.084)	[1.261 , 1.584]
Intercept_{2001}	1.481 (0.085)	[1.321 , 1.648]
Intercept_{2002}	1.496 (0.093)	[1.314 , 1.685]
$\sigma_{Intercept}$	0.007 (0.004)	[0.003 , 0.016]

2.4 Model 4

Table 7: Bayesian Negative Binomial Regression of Substitution with Allies (Model 4 lagged DV)

Variable	β (S.D.)	95% CI
Effective Number, ln	0.111 (0.035)	[0.043 , 0.180]
Minority Regime	0.239 (0.053)	[0.137 , 0.344]
E.N., ln × Min. Reg.	-0.270 (0.091)	[-0.447 , -0.089]
Rivals' Strength	-0.037 (0.009)	[-0.054 , -0.020]
Polity2	-0.037 (0.002)	[-0.041 , -0.033]
OIL	-0.014 (0.031)	[-0.074 , 0.048]
CINC	-7.499 (0.669)	[-8.812 , -6.170]
Mountainous Terrain, ln	-0.122 (0.009)	[-0.140 , -0.105]
Middle East	0.233 (0.038)	[0.159 , 0.307]
Ally of the United States	0.005 (0.046)	[-0.087 , 0.092]
Ally of Great Britain	0.271 (0.058)	[0.153 , 0.385]
Ally of Russia/USSR	0.404 (0.037)	[0.331 , 0.478]
Ally of France	0.800 (0.054)	[0.695 , 0.906]
Ally of China	0.588 (0.088)	[0.416 , 0.759]
Defense Pacts$_{t-1}$	0.128 (0.002)	[0.124 , 0.132]
Intercept	0.220 (0.035)	[0.150 , 0.286]
Rate	3.925 (0.199)	[3.545 , 4.334]

Table 8: Bayesian Negative Binomial Regression of Substitution with Allies (Model 4 varying intercepts)

Variable	β (S.D.)	95% CI
Effective Number, ln	0.180 (0.071)	[0.038 , 0.316]
Minority Regime	0.248 (0.108)	[0.036 , 0.466]
E.N., ln × Min. Reg.	-0.036 (0.183)	[-0.399 , 0.308]
Rivals' Strength	-0.073 (0.017)	[-0.107 , -0.038]
Polity2	-0.049 (0.004)	[-0.058 , -0.040]
OIL	0.010 (0.063)	[-0.111 , 0.134]
CINC	15.987 (1.055)	[13.953 , 18.054]
Mountainous Terrain, ln	-0.197 (0.018)	[-0.234 , -0.163]
Middle East	1.625 (0.074)	[1.485 , 1.777]
Ally of the United States	2.488 (0.069)	[2.356 , 2.625]
Ally of Great Britain	-0.157 (0.137)	[-0.417 , 0.108]
Ally of Russia/USSR	0.256 (0.071)	[0.119 , 0.400]
Ally of France	0.313 (0.120)	[0.085 , 0.554]
Ally of China	0.066 (0.178)	[-0.275 , 0.427]
Rate	0.607 (0.018)	[0.571 , 0.641]
Intercept_{1970}	0.567 (0.114)	[0.344 , 0.794]
Intercept_{1971}	0.574 (0.108)	[0.360 , 0.780]
Intercept_{1972}	0.593 (0.100)	[0.396 , 0.798]
Intercept_{1973}	0.623 (0.097)	[0.436 , 0.814]
Intercept_{1974}	0.655 (0.094)	[0.470 , 0.841]
Intercept_{1975}	0.668 (0.093)	[0.480 , 0.852]
Intercept_{1976}	0.692 (0.091)	[0.504 , 0.866]
Intercept_{1977}	0.736 (0.086)	[0.563 , 0.898]
Intercept_{1978}	0.780 (0.085)	[0.620 , 0.954]
Intercept_{1979}	0.841 (0.085)	[0.669 , 1.009]
Intercept_{1981}	0.909 (0.085)	[0.740 , 1.076]
Intercept_{1982}	1.027 (0.081)	[0.877 , 1.195]
Intercept_{1983}	1.096 (0.081)	[0.948 , 1.256]
Intercept_{1984}	1.130 (0.082)	[0.970 , 1.295]
Intercept_{1985}	1.146 (0.080)	[0.987 , 1.304]
Intercept_{1986}	1.153 (0.081)	[0.999 , 1.309]
Intercept_{1987}	1.157 (0.084)	[0.993 , 1.318]
Intercept_{1988}	1.165 (0.084)	[0.992 , 1.329]
Intercept_{1989}	1.186 (0.085)	[1.029 , 1.353]
Intercept_{1990}	1.220 (0.083)	[1.060 , 1.386]
Intercept_{1991}	1.259 (0.083)	[1.099 , 1.422]
Intercept_{1992}	1.282 (0.079)	[1.131 , 1.437]
Intercept_{1993}	1.292 (0.080)	[1.139 , 1.450]
Intercept_{1994}	1.327 (0.083)	[1.167 , 1.494]
Intercept_{1995}	1.328 (0.081)	[1.168 , 1.491]
Intercept_{1996}	1.331 (0.085)	[1.159 , 1.497]
Intercept_{1997}	1.344 (0.083)	[1.174 , 1.504]
Intercept_{1998}	1.382 (0.082)	[1.216 , 1.547]
Intercept_{1999}	1.408 (0.084)	[1.245 , 1.580]
Intercept_{2000}	1.429 (0.084)	[1.257 , 1.589]
Intercept_{2001}	1.483 (0.086)	[1.316 , 1.647]
Intercept_{2002}	1.497 (0.096)	[1.318 , 1.692]
$\sigma_{Intercept}$	0.007 (0.004)	[0.003 , 0.016]

3 Bayesian Model Paramaterization and JAGS Code

3.1 Negative Binomial Regression

We estimate Bayesian negative binomial regression equations for alliance dependent count variable for each country i in each year t from 1970 to 2002. Here we briefly review the parameterization of this model and its alternatives.

The systematic component of the model is $\mu_{it} = exp(\alpha + \mathbf{X}\beta)$, where $\mathbf{X}$ is the matrix of explanatory variables and β is the vector of slope coefficients. For the model with time varying intercepts the model is $\mu_{it} = exp(\alpha_t + \mathbf{X}\beta)$. μ_{it} is the expected value of the count variable y_{it}, conditional on the model parameters, such that $E[y_{it}|\mu_{it}, r]$. The stochastic component of the model is $y_{it} \sim NB(\mu_{it}, r)$, where the negative binomial distribution $NB()$ is $\frac{\Gamma(r+k)}{\Gamma(r)k!}(\frac{r}{\mu_{it}+r})^r(\frac{\mu_{it}}{\mu_{it}+r})^k$. r is the over dispersion parameter to be estimated. The likelihood function for the parameters μ and r given the data y is

$$\mathscr{L}(\mu, r|y) = \prod_{i=1}^{N}\prod_{t=1}^{T}\left[\frac{\Gamma(r+y_{it})}{\Gamma(r)y_{it}!}\left(\frac{r}{\mu_{it}+r}\right)^r\left(\frac{\mu_{it}}{\mu_{it}+r}\right)^{y_{it}}\right]$$

The negative binomial distribution arises from a variety of processes and can be parameterized in several ways. We have used the "ecological" parameterization of the negative binomial regression model as described above. Note that the term "ecological" is not meant to imply that an ecological inference problem exists. It is instead a count process that arises from a system of heterogeneous units much like the international system of states. There is also a probabilistic parameterization for the negative binomial distribution, which is also known as the "failure-process" parameterization. These models are mathematically identical but are motivated by different phenomenological processes (see the discussion in Bolker (2008), 165-167). The JAGS software, which is briefly discussed below, only implements the probabilistic parameterization, so the code re-parameterizes the ecological model into the probabilistic one. The expected value of the probabilistic model in terms of the ecological model is $\mu_{it} = \frac{r*(1-p_{it})}{p_{it}}$ and the variance of the probabilistic parameterization in terms of the ecological parameterization is $\mu_{it} + \frac{\mu_{it}^2}{r} = \frac{r*(1-p_{it})}{p_{it}^2}$.

Note that the probabilistic parameterization assumes that r is a positive integer, whereas the ecological parameterization allows r to be a positive real number. This is useful for our statistical model, since we wish to account for the heterogeneity between units in the international system and not the number of successes in a set of trials. A smaller estimated value of r indicates an increasing amount of heterogeneity in the data. As r increases, the variance ($\mu_{it} + \frac{\mu_{it}^2}{r}$) approaches the mean ($\mu_{it}$) and the distribution therefore begins to approximate a Poisson distribution. The estimated value of r in each of the models displayed in the Tables above are all very small values. The small size of the over dispersion parameters indicates a high degree of heterogeneity in the data, which means the negative binomial is a good choice of estimator, relative to the Poisson.[1]

Each of the Bayesian negative binomial regression equations are implemented in R using Martyn Plummer's JAGS software (Plummer, 2010). Conventional diagnostics all suggested convergence including those of Geweke (1992), Heidelberger and Welch (1981, 1983), and Gelman and Rubin (1992), and standard graphical analysis. The α (intercept) and β_j (slope) parameters were given $N(0,10)$ priors which are extremely diffuse. For the time varying version of the model the intercepts α_t are estimate dynamically such that $\alpha_t \sim N(\alpha_{t-1}, \sigma)$ for all i and t except when $t = 1$

[1] See King (1989) for a discussion of this choice when considering international relations data.

and then is $\alpha_{t=1} \sim N(0,1)$. The variance for the α_t parameters is modeled as $\sigma \sim U(0,1)$. Results are consistent with a static prior for α_t such that $\alpha_t \sim N(0,1)$ for each year. Finally, the over dispersion parameter r is also given a diffuse prior $U(0,100)$. The JAGS code is displayed below.

3.2 Negative Binomial Regression with Lagged Dependent Variable

```
model{
 for(i in 1:n){# n is the number of obs

   xb[i] <- alpha[time[i]] + beta[1]*x[i,1] + beta[2]*x[i,2] + beta[3]*x[i,3]
   + beta[4]*x[i,4] + beta[5]*x[i,5] + beta[6]*x[i,6] + beta[7]*x[i,7]
   + beta[8]*x[i,8] + beta[9]*x[i,9] + beta[10]*x[i,10] + beta[11]*x[i,11]
   + beta[12]*x[i,12] + beta[13]*x[i,13] + beta[14]*x[i,14] + beta[15]*x[i,15]

   lambda[i] <- exp(xb[i])
   p[i] <- rate/(rate + lambda[i])
   y[i] ~ dnegbin(p[i], rate)
 }

  for( j in 1:K){
  beta[j] ~ dnorm(0, 0.1)
  }
  alpha ~ dnorm(0, 0.1)
  rate ~ dunif(0, 1000)
}
```

3.3 Negative Binomial Regression with Time Varying Intercepts

```
model{
 for(i in 1:n){# n is the number of obs

   xb[i] <- alpha[time[i]] + beta[1]*x[i,1] + beta[2]*x[i,2] + beta[3]*x[i,3]
   + beta[4]*x[i,4] + beta[5]*x[i,5] + beta[6]*x[i,6] + beta[7]*x[i,7]
   + beta[8]*x[i,8] + beta[9]*x[i,9] + beta[10]*x[i,10] + beta[11]*x[i,11]
   + beta[12]*x[i,12] + beta[13]*x[i,13] + beta[14]*x[i,14]

   lambda[i] <- exp(xb[i])
   p[i] <- rate/(rate + lambda[i])
   y[i] ~ dnegbin(p[i], rate)
 }

  for( j in 1:K){
  beta[j] ~ dnorm(0, 0.1)
  }

 sigma ~ dunif(0,100)
 kappa <- pow(sigma, -1)

 alpha[1] ~ dnorm(0, 1)
 for(t in 2:T){
  alpha[t] ~ dnorm(alpha[t-1], kappa)
 }

  rate ~ dunif(0, 1000)
}
```

4 Model of Covariance between Equations

Here we estimate several models with correlated variance components, which allow us to assess the indirect relationship between a model of strategic substation (DV1) and a model of coup proofing (DV2). A positive covariance term (which varies from -1 to 1) is evidence that the two processes are related even when we do not model the direct relationship between these variables in a single equation. We estimated Bayesian version of these models primarily because they give us a lot of control over how we model the endogenous relationships across the two equations. There is perhaps too much flexibility with these models and we have explored many other variants, which we do not report here. Overall, we have found that the core results we present in the main manuscript are consistent across these alternatives. The covariance between equations modeling possession of WMD and coup proofing though positive is not substantively large. On the other hand, the Count of Defense Pacts equation and the pursuit of the WMD equations strongly covary with the coup proofing equation. Overall, this provides some additional evidence of the relationship between the process of coup proofing and strategic substitution is consistent with the logic of our theory.

Table 9: Covariance between linear equations for two Dependent Variables

DV1	DV2	ρ	std. dev. ρ	95% Credible Intervals
Pursue Chemical/Biological Weapons	Effective Number	0.712	0.234	[0.139 0.975]
Pursue Nuclear Weapons	Effective Number	0.706	0.243	[0.113 0.973]
Possess Chemical/Biological Weapons	Effective Number	-0.046	0.046	[-0.112 -0.001]
Possess Nuclear Weapons	Effective Number	0.003	0.002	[-0.001 0.006]
Count of Defense Pacts	Effective Number	0.707	0.236	[0.053 0.973]
Pursue Chemical/Biological Weapons	Minority Regime	0.682	0.240	[0.108 0.969]
Pursue Nuclear Weapons	Minority Regime	0.697	0.235	[0.102 0.973]
Possess Chemical/Biological Weapons	Minority Regime	0.003	0.002	[0.000 0.007]
Possess Nuclear Weapons	Minority Regime	0.003	0.002	[0.000 0.007]
Count of Defense Pacts	Minority Regime	0.711	0.226	[0.175 0.964]

4.1 Model of Covariance between Equations JAGS code

```
model{
 for(i in 1:n){# n is the number of obs

  xb1[i] <- alpha1 + beta1[1]*x1[i,1] + beta1[2]*x1[i,2] + beta1[3]*x1[i,3]
  + beta1[4]*x1[i,4] + beta1[5]*x1[i,5] + beta1[6]*x1[i,6] + beta1[7]*x1[i,7]
  + beta1[8]*x1[i,8] + beta1[9]*x1[i,9] + beta1[10]*x1[i,10]
  + beta1[11]*x1[i,11] + beta1[12]*x1[i,12]
  y1[i] ~ dnorm(xb1[i], tau1)

  xb2[i] <- alpha2 + beta2[1]*x2[i,1] + beta2[2]*x2[i,2] + beta2[3]*x2[i,3]
  + beta2[4]*x2[i,4] + beta2[5]*x2[i,5] + beta2[6]*x2[i,6] + beta2[7]*x2[i,7]
  + beta2[8]*x2[i,8] + beta2[9]*x2[i,9] + beta2[10]*x2[i,10]
  + beta2[11]*x2[i,11] + beta2[12]*x2[i,12]
  y2[i] ~ dnorm(xb2[i], tau2)

 }

  for(j in 1:K1){
   beta1[j] ~ dnorm(0, 0.1)
  }
  for(j in 1:K2){
   beta2[j] ~ dnorm(0, 0.1)
  }

  alpha1 ~ dnorm(0, 0.1)
  alpha2 ~ dnorm(0, 0.1)

# rho is the covariance between equations
 rho ~ dunif(-1,1)

# partially observed covariance matrix
 b0[1] <- 0
 b0[2] <- 0
 B0[1,1] <- 1
 B0[2,2] <- 1
 B0[1,2] <- rho
 B0[2,1] <- rho

 prec[1:2,1:2] <- inverse(B0[,])
 SIGMA[1:2] ~ dmnorm(b0, prec)

 sigma1 <- SIGMA[1]
 sigma2 <- SIGMA[2]
 tau1 <- exp(sigma1)
 tau2 <- exp(sigma2)
}
```

5 Negative Binomial Regression with Country Fixed Effects

Unobserved, unit-level heterogeneity remains a concern for our analysis. In order to account for this possibility, we include country fixed effects within the negative binomial regression tests for the Allies Count dependent variable. Unfortunately, we cannot conduct a similar robustness check for the WMD tests. Country fixed effects analysis depends on variation over time within each state. Where variables remain constant across time for the state, there exists no variation to use for identifying parameters, and the case is dropped. This often poses a problem for tests of binary dependent variables. In our case, for example, states that never possessed nuclear weapons (e.g. Senegal) or that possessed the weapons throughout the sample period (e.g. China) would be dropped from the tests of Nuclear Weapons Possession. The same is true for the other pursuit and possession dependent variables, respectively. Consequently, we would lose most of our sample when using fixed effects. Much of the interesting variation within the Allies Count tests is also cross-national, though the nature of the dependent variable makes fixed effects analysis feasible.

5.1 Allies Count Models

Table 10: Fixed Effects Negative Binomial Regression of Substitution with Allies

	Count of Defense Pacts			
	(1)	(2)	(3)	(4)
Effective Number, ln	0.013		0.013	0.020
	(0.023)		(0.023)	(0.025)
Minority Regime		$0.068^{\dagger}$	0.132^{**}	0.152^{**}
		(0.041)	(0.047)	(0.055)
E.N., ln × Min. Reg.				-0.037
				(0.053)
Rivals' Strength	0.008	0.004	0.008	0.008
	(0.006)	(0.005)	(0.006)	(0.006)
Polity2	-0.006^{***}	-0.007^{***}	-0.005^{***}	-0.005^{***}
	(0.001)	(0.001)	(0.001)	(0.001)
Oil	-0.018	-0.013	-0.018	-0.019
	(0.028)	(0.026)	(0.028)	(0.028)
CINC	-0.140	-0.268	-0.112	-0.080
	(1.019)	(1.016)	(1.019)	(1.020)
Mountainous Terrain, ln	5.100	5.160	5.062	5.108
	(170.673)	(160.759)	(161.254)	(173.122)
Middle East	12.430	12.436	12.363	12.458
	(348.615)	(328.364)	(329.375)	(353.616)
Ally of United States	0.560^{***}	0.629^{***}	0.562^{***}	0.561^{***}
	(0.105)	(0.102)	(0.105)	(0.105)
Ally of Great Britain	0.877^{***}	0.621^{***}	0.882^{***}	0.883^{***}
	(0.143)	(0.136)	(0.142)	(0.142)
Ally of Russia/USSR	0.122^{**}	0.101^{**}	0.124^{**}	0.124^{**}
	(0.039)	(0.039)	(0.039)	(0.039)
Ally of France	-0.209	-0.015	-0.216	-0.215
	(0.135)	(0.121)	(0.135)	(0.135)
Ally of China	-0.012	-0.012	-0.012	-0.014
	(0.086)	(0.086)	(0.086)	(0.086)
Defense Pacts$_{t-1}$	0.052^{***}	0.056^{***}	0.051^{***}	0.051^{***}
	(0.001)	(0.001)	(0.001)	(0.001)
Intercept	-17.326	-17.508	-17.201	-17.360
	(576.464)	(542.978)	(544.649)	(584.734)
Country Fixed Effects?	Yes	Yes	Yes	Yes
α, ln	-48.024	-22.510	-40.871	-58.581
	(.)	(.)	(.)	(.)
N	3900	4301	3900	3900

Significance Levels: † ($p \leq 0.1$),* ($p \leq 0.05$), ** ($p \leq 0.01$), *** ($p \leq 0.001$).
Each model utilizes robust standard errors.
Notes: Results for negative binomial regression tests with country fixed effects. The dependent variable counts the number of countries each state has a defense pact with in a given year. The sample is inclusive to all states in the international system from 1970-2001.

6 Regression Models with Alternative Measure of Rivalry

In this section, we replicate the main regression results presented in Tables 2-4 with an alternative measure of rivalry. Instead of using the measure based on the summed relative CINC ratios of states and their rivals, we simply count the number of rivals that states have in a given year, forming a "Count of Rivals" variable that is included in the analysis presented below. The results for these models are largely consistent with those presented in the paper, though there are a couple of notable differences. The relationship between Minority Regime and the Possession of Chemical or Biological Weapons is weakened somewhat in the alternative specification. However, the relationship between coup-proofing and alliances appears stronger in models with the Count of Rivals variable.

6.1 Pursuit and Possession of Nuclear Weapons

Table 11: GEE Logistic Regression on Nuclear Weapons with Alternate Rivals Measure

	Pursue Nuclear Weapons				Possess Nuclear Weapons			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Effective Number, ln	1.169*		1.130*	0.580	7.725***		7.304***	11.732*
	(0.548)		(0.548)	(0.560)	(1.909)		(1.963)	(5.621)
Minority Regime		0.518	0.440	-3.488		3.840***	1.345†	-78.349**
		(1.246)	(1.013)	(2.160)		(0.698)	(0.779)	(26.063)
E.N., ln × Min. Reg.				6.701**				83.172**
				(2.302)				(28.208)
Count of Rivals	0.163	0.215	0.131	0.255	0.619*	0.444***	0.555*	1.097**
	(0.136)	(0.180)	(0.169)	(0.172)	(0.292)	(0.131)	(0.271)	(0.424)
Polity2	-0.013	0.012	-0.015	-0.005	0.238*	0.154*	0.233†	0.643*
	(0.047)	(0.048)	(0.048)	(0.050)	(0.110)	(0.077)	(0.128)	(0.303)
Oil	0.675	0.401	0.668	1.054*	-7.990	-6.038	-7.623	-6.461*
	(0.455)	(0.661)	(0.446)	(0.503)	(5.054)	(3.760)	(5.263)	(3.180)
CINC	66.855**	63.936**	69.343**	62.399**	136.534**	112.103*	138.958**	187.557†
	(21.136)	(24.154)	(22.495)	(22.858)	(42.598)	(45.371)	(46.464)	(111.651)
Mountainous Terrain, ln	0.243†	0.334*	0.263†	0.217†	-0.687	0.114	-0.656	-0.171
	(0.140)	(0.137)	(0.136)	(0.129)	(0.586)	(0.256)	(0.663)	(0.365)
Middle East	1.272*	1.711**	1.371*	1.519*	4.879**	3.496**	5.234***	7.542*
	(0.643)	(0.630)	(0.608)	(0.645)	(1.611)	(1.268)	(1.562)	(3.632)
Ally of United States	1.779*	2.868***	1.885*	2.378**	4.550**	3.766†	4.932***	8.026***
	(0.825)	(0.762)	(0.764)	(0.778)	(1.538)	(1.957)	(1.360)	(2.096)
Ally of Great Britain	-1.211	-1.884	-1.219	-1.372	-3.072	-2.503	-3.295	-9.122**
	(1.379)	(1.525)	(1.381)	(1.364)	(3.586)	(2.095)	(3.658)	(3.224)
Ally of Russia/USSR	0.316	1.053	0.323	0.708	2.253	2.507	2.424	5.825**
	(0.684)	(0.645)	(0.660)	(0.702)	(2.144)	(1.545)	(2.113)	(2.141)
Ally of France	2.173*	2.397*	2.225*	1.996*	-0.246	0.517	-0.036	-2.591*
	(0.944)	(1.109)	(0.987)	(0.970)	(1.217)	(1.484)	(1.418)	(1.218)
Ally of China	4.403***	4.972***	4.531***	4.727***	3.119**	4.642***	3.301**	2.643*
	(1.170)	(1.085)	(1.107)	(1.135)	(1.144)	(0.928)	(1.263)	(1.048)
Time Count	-2.241***	-2.201***	-2.234***	-2.256***	-2.109**	-1.889**	-1.955**	-2.837***
	(0.412)	(0.432)	(0.410)	(0.428)	(0.645)	(0.613)	(0.688)	(0.779)
Time Count^2	0.116***	0.112***	0.115***	0.116***	0.079**	0.071*	0.073**	0.096***
	(0.022)	(0.023)	(0.022)	(0.022)	(0.025)	(0.030)	(0.027)	(0.026)
Time Count^3	-0.002***	-0.002***	-0.002***	-0.002***	-0.001**	-0.001*	-0.001*	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Intercept	-2.135**	-2.861***	-2.254***	-2.355***	-6.839***	-4.343***	-7.091***	-14.396*
	(0.662)	(0.539)	(0.574)	(0.609)	(1.718)	(1.066)	(1.701)	(7.248)
N	3774	4235	3774	3774	3997	4458	3997	3997

Significance Levels: † ($p \leq 0.1$),* ($p \leq 0.05$), ** ($p \leq 0.01$), *** ($p \leq 0.001$).
Robust standard errors clustered by state are presented in parentheses.
Notes: Results for General Estimation Equation (GEE) logistic regression tests. Models 1-4 utilize a dependent variable indicating whether states are *pursuing* nuclear weapons. Models 5-8 are tests on a dependent variable that denotes whether or not a state has already *acquired* nuclear weapons. Once states have acquired nuclear weapons, they are omitted from the sample of state-years for which nuclear weapons can be pursued. The tests are inclusive to state-years from 1970-2001. Each GEE model assumes an independent correlation structure. In order to account for autocorrelation, all models are run with polynomial time variables counting years since a state had an pursued or possessed nuclear weapons.

6.2 Pursuit and Possession of Chemical/Biological Weapons

Table 12: GEE Logistic Regression on Chem./Bio. Weapons with Alternate Rivals Measure

	Pursue Chemical/Biological Weapons				Possess Chemical/Biological Weapons			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Effective Number, ln	0.904 †		0.928†	1.115*	-0.776		-1.428	-1.359
	(0.525)		(0.517)	(0.564)	(0.871)		(0.941)	(1.032)
Minority Regime		0.186	0.340	1.345†		1.719	1.593	1.709
		(0.455)	(0.435)	(0.817)		(1.255)	(1.391)	(1.773)
E.N., ln × Min. Reg.				-1.865†				-0.214
				(1.121)				(2.160)
Count of Rivals	0.414***	0.298*	0.406**	0.414**	0.709*	0.702**	0.686*	0.686*
	(0.123)	(0.148)	(0.125)	(0.126)	(0.276)	(0.262)	(0.306)	(0.305)
Polity2	-0.077***	-0.081***	-0.076***	-0.076***	-0.125	-0.163†	-0.148	-0.147
	(0.020)	(0.023)	(0.020)	(0.020)	(0.084)	(0.099)	(0.103)	(0.099)
Oil	-0.065	-0.234	-0.132	-0.205	-2.865†	-2.807*	-2.569	-2.543
	(0.391)	(0.441)	(0.405)	(0.404)	(1.540)	(1.267)	(1.645)	(1.640)
CINC	32.095	30.753	34.046	34.870	192.078†	207.171*	196.131†	195.301†
	(21.542)	(22.032)	(22.134)	(22.138)	(115.347)	(98.052)	(104.144)	(103.932)
Mountainous Terrain, ln	0.335**	0.245*	0.338**	0.348**	-0.202	-0.021	-0.105	-0.107
	(0.119)	(0.114)	(0.118)	(0.120)	(0.392)	(0.384)	(0.450)	(0.453)
Middle East	-0.063	0.506	-0.057	-0.116	5.082†	5.134*	4.697†	4.655†
	(0.627)	(0.588)	(0.620)	(0.614)	(2.994)	(2.046)	(2.416)	(2.450)
Ally of United States	0.020	0.625	-0.002	-0.016	-4.325	-2.797	-3.658	-3.618
	(0.426)	(0.456)	(0.432)	(0.426)	(3.003)	(2.819)	(2.808)	(2.827)
Ally of Great Britain	-1.789	-2.124†	-1.819	-1.805	3.324	3.042	3.596†	3.547†
	(1.351)	(1.270)	(1.354)	(1.361)	(1.916)	(1.908)	(1.931)	(1.976)
Ally of Russia/USSR	-0.019	0.280	-0.030	-0.012	-1.684†	-2.020	-2.256*	-2.250*
	(0.441)	(0.421)	(0.440)	(0.449)	(0.975)	(1.239)	(1.142)	(1.139)
Ally of France	1.423	1.269	1.490	1.540	0.196	0.144	0.233	0.274
	(1.260)	(1.271)	(1.259)	(1.259)	(2.554)	(2.355)	(2.656)	(2.729)
Ally of China	2.200**	2.258***	2.249**	2.228**	6.818*	7.798**	7.815**	7.807**
	(0.752)	(0.662)	(0.736)	(0.741)	(2.663)	(2.380)	(2.699)	(2.717)
Time Count	-2.321***	-2.190***	-2.313***	-2.315***	-2.698***	-2.308***	-2.591***	-2.597***
	(0.380)	(0.341)	(0.381)	(0.377)	(0.573)	(0.392)	(0.477)	(0.478)
Time Count^2	0.105***	0.099***	0.104***	0.104***	0.123***	0.101***	0.116***	0.117***
	(0.019)	(0.017)	(0.019)	(0.019)	(0.032)	(0.022)	(0.026)	(0.026)
Time Count^3	-0.001***	-0.001***	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Intercept	-0.101	0.268	-0.150	-0.281	1.422†	-0.435	1.193	1.178
	(0.434)	(0.361)	(0.431)	(0.452)	(0.828)	(0.837)	(1.043)	(1.041)
N	3485	3941	3485	3485	3842	4298	3842	3842

Significance Levels: † ($p \leq 0.1$),* ($p \leq 0.05$), ** ($p \leq 0.01$), *** ($p \leq 0.001$).
Robust standard errors clustered by state are presented in parentheses.
Notes: Results for General Estimation Equation (GEE) logistic regression tests. Models 1-4 utilize a dependent variable indicating whether states are *pursuing* chemical or biological weapons. Models 5-8 are tests on a dependent variable that denotes whether or not a state has already *acquired* chemical or biological weapons. Once states have acquired chemical or biological weapons, they are omitted from the sample of state-years for which chemical or biological weapons can be pursued. The tests are inclusive to state-years from 1970-2001. Each GEE model assumes an independent correlation structure. In order to account for autocorrelation, all models are run with polynomial time variables counting years since a state had an pursued or possessed chemical or biological weapons.

6.3 Allies Count Analysis

Table 13: Negative Binomial Regression of Substitution with Allies and Alternate Rivals Measure

	Count of Defense Pacts			
	(1)	(2)	(3)	(4)
Effective Number, ln	0.070†		0.072†	0.121**
	(0.038)		(0.037)	(0.040)
Minority Regime		0.110***	0.138***	0.293***
		(0.033)	(0.032)	(0.056)
E.N., ln $\times$ Min. Reg.				-0.332***
				(0.090)
Count of Rivals	-0.029***	-0.035***	-0.036***	-0.038***
	(0.007)	(0.007)	(0.007)	(0.007)
Polity2	-0.038***	-0.034***	-0.037***	-0.037***
	(0.003)	(0.003)	(0.003)	(0.003)
Oil	0.004	-0.015	-0.001	-0.004
	(0.031)	(0.032)	(0.031)	(0.031)
CINC	-6.103***	-4.929***	-5.688***	-5.719***
	(1.350)	(1.353)	(1.348)	(1.351)
Mountainous Terrain, ln	-0.126***	-0.135***	-0.125***	-0.125***
	(0.011)	(0.010)	(0.011)	(0.010)
Middle East	0.245***	0.305***	0.248***	0.241***
	(0.048)	(0.049)	(0.047)	(0.047)
Ally of United States	-0.030	0.003	-0.020	-0.023
	(0.094)	(0.086)	(0.093)	(0.093)
Ally of Great Britain	0.297***	0.274***	0.292***	0.284***
	(0.074)	(0.072)	(0.074)	(0.074)
Ally of Russia/USSR	0.399***	0.476***	0.406***	0.405***
	(0.039)	(0.041)	(0.039)	(0.039)
Ally of France	0.774***	0.765***	0.789***	0.802***
	(0.057)	(0.055)	(0.057)	(0.057)
Ally of China	0.588***	0.657***	0.609***	0.607***
	(0.089)	(0.090)	(0.089)	(0.089)
Defense Pacts$_{t-1}$	0.129***	0.134***	0.128***	0.128***
	(0.004)	(0.004)	(0.004)	(0.004)
Intercept	0.249***	0.161***	0.232***	0.210***
	(0.047)	(0.046)	(0.047)	(0.047)
α, ln	-1.359***	-1.221***	-1.370***	-1.374***
	(0.081)	(0.072)	(0.082)	(0.082)
N	3900	4301	3900	3900

Significance Levels: † ($p \leq 0.1$),* ($p \leq 0.05$), ** ($p \leq 0.01$), *** ($p \leq 0.001$).
Each model utilizes robust standard errors.
Notes: Results for negative binomial regression tests. The dependent variable counts the number of countries each state has a defense pact with in a given year. The sample is inclusive to all states in the international system from 1970-2001.

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