Proper Specification of Non-proportional Hazards Corrections in Duration Models[1]

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A. SUPPLEMENTAL APPENDIX

A.1. *Monte Carlo Analysis*

To explore the consequences of misspecifying the correction for non-proportional hazards, we ran a Monte Carlo simulation. Here we set up duration data for 500 units with durations lasting up to 500 time periods and censored thereafter. We set up the data using a logit data generating process for each of the 500 time periods with time-invariant covariates, one of which has an effect that varies over time, and a cubic time trend. We estimate a semi-parametric Cox model using the properly specified time varying data setup. We also estimate a time-invariant version of the model using the data from the last observed time period for each unit. Finally, we estimate the associated logit model just for comparison.

Specifically, we generate 250,000 data points representing 500 units over 500 time periods as follows:

$$y_i^* = -5 - 0.5x_1 + 0.1x_{1i}\ln(t) + 0.5x_{2i} + 0.001t - 0.0001t^2 + 0.00000023t^3 + u_i. \quad (4)$$

Both independent variables are i.i.d. standard normal and u_i is logistic. We then set $y_i = 1$ if $y_i^* > 0$ and $y_i = 0$ otherwise. For each unit we mark the first time period in which a 1 appears as the failure time t and discard the data from subsequent time periods. We mark a unit as right censored at 500 if no success occurs by then.

We repeat the simulation 1000 times and save the resulting parameter estimates. Figures A1 through A3 report the distribution of the estimates from the three different models. Figure A1 clearly indicates that the incorrect time invariant specification leads to incorrect estimates, with the average estimates off by about 135% whereas the correct time-varying and logit specifications cluster around the true value. Figure A2 shows apparent bias in the coefficient capturing the time varying effect, with the average estimate from the incorrect specification almost exactly 100% too large. Finally, Figure A3 shows the results for the coefficient on the uncorrelated control variable, X_2. These appear to be accurately estimated by all three models.

We then plot the estimated marginal effect of the variable of interest, X_1, which varies over time, from the correctly and incorrectly specified Cox models. Figure A4 shows the average effect by using the average coefficient estimates from the 1000 draws while Figure A5 shows the effect and associated standard errors from one draw. Both illustrate the results found in the previous density plots: the effect starts out too large and then decreases too quickly in the incorrect time-invariant specification. The magnitude of the effect is generally too large and the points in time at which it changes signs very different, occurring about 200 points in time too late in the incorrectly specified model. Further, the effect is negative and significant for just a handful of cases in the correctly specified model on the left but for over half the cases in the incorrectly specified model on the right.

Overall, then, these results clearly indicate that incorrectly specifying the correction for NPH can produce biased parameters, wildly inaccurate substantive effects, and misleading results for hypothesis tests.

Figure A1: Distribution of Estimated Coefficients on X_1 by specification
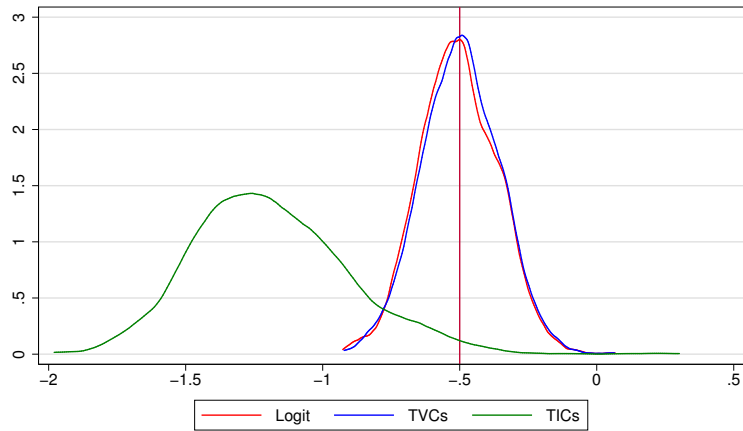
Figure A2: Distribution of Estimated Coefficients on $X_1 * \ln(time)$ by specification
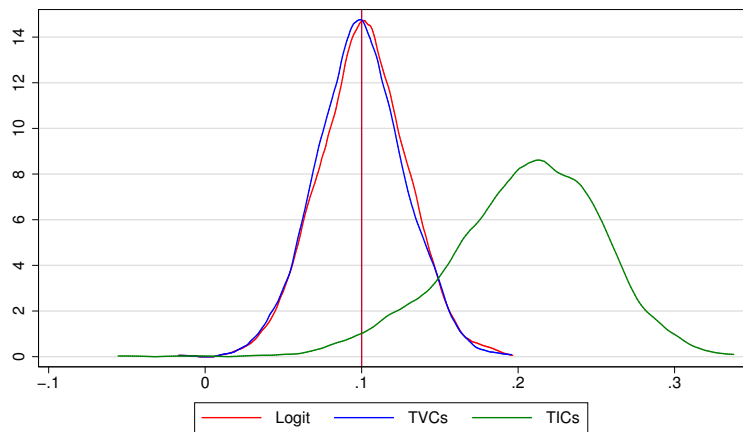
Figure A3: Distribution of Estimated Coefficients on X_2 by specification
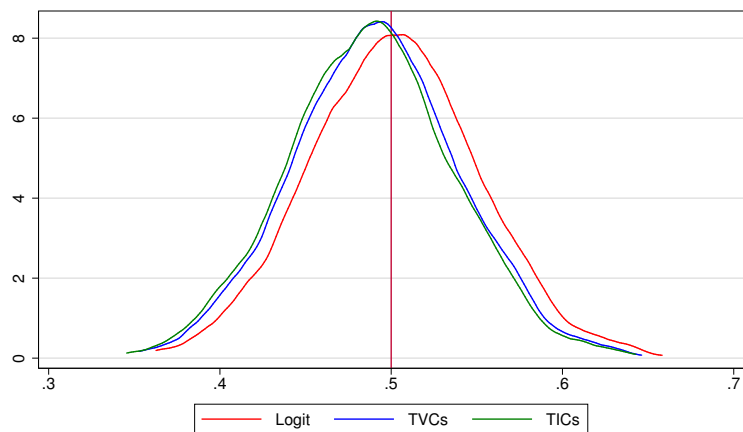
Notes. All results based on 1000 draws.

Figure A4: Comparison of Marginal Effects (Average Estimates)
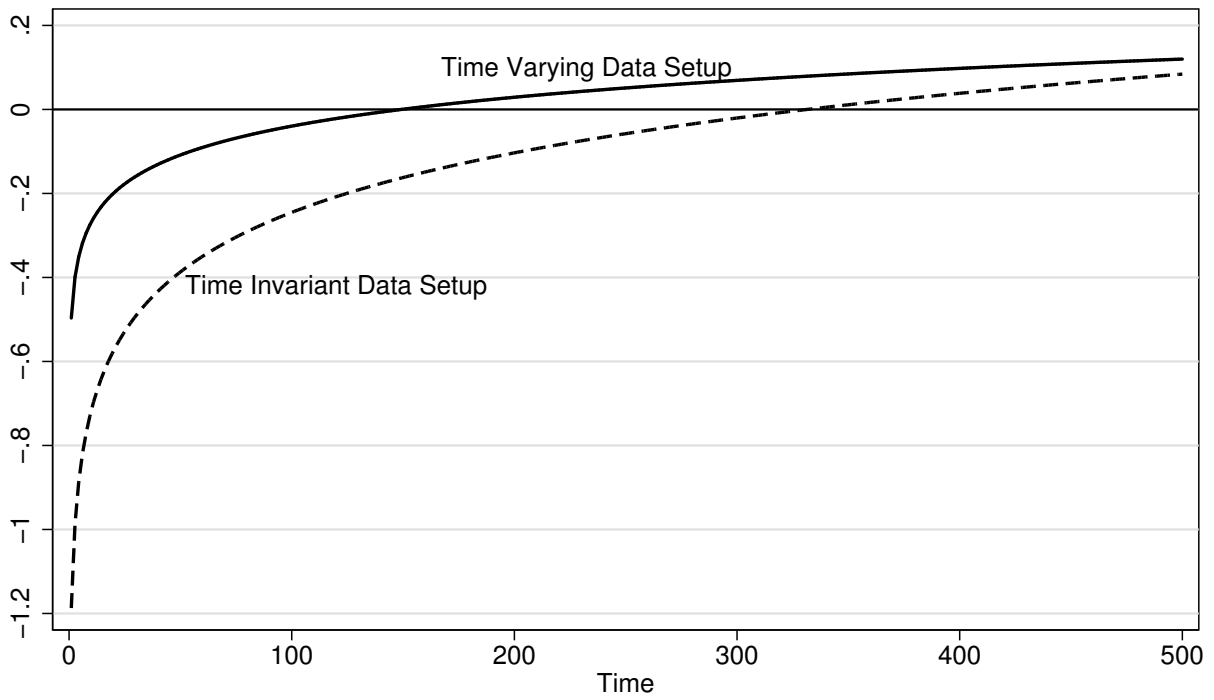
Notes. Marginal effect calculated using the average estimates of the two underlying parameters from the 1000 Monte Carlo draws.

Figure A5: Example of Estimated Marginal Effects with Confidence Interval
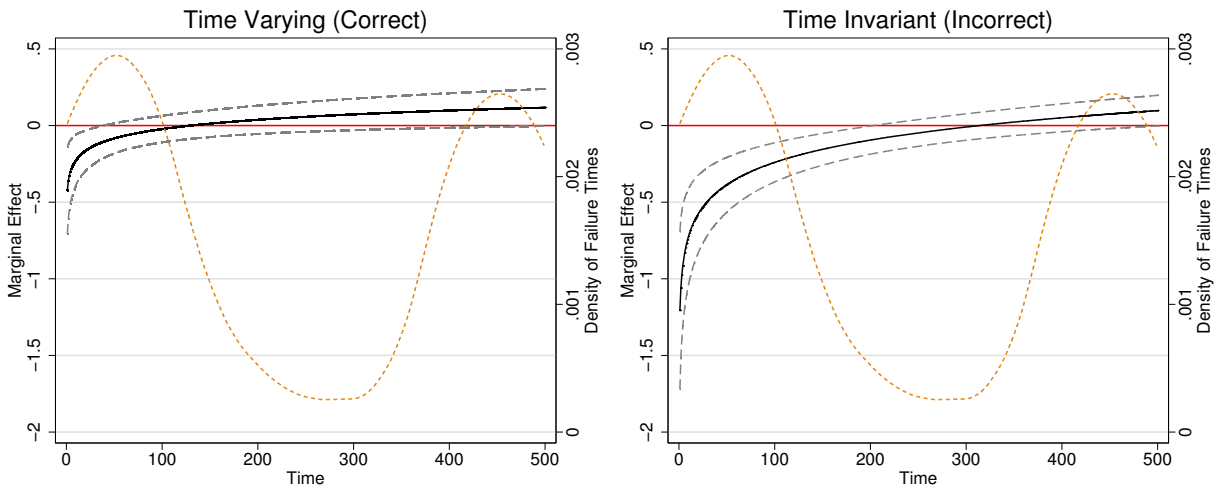
Notes. Marginal effect calculated for one draw of the simulation data. Dashed lines give 95% confidence interval. Short dashed dark orange line represents a kernel density plot of observed failure or censoring times.

A.2. *Replication and Reanalysis Results*

Table A1: Summary of Studies Examined and results of Tests for NPH and Correction as Warranted

Studies	Source	Journal	Perform PH test	Implement correction	Base Model	If TVC, Scales Match	Proper Adjustment
Balch-Lindsay, Enterline 2001	Box-Steffensmeier et al. 2003	ISQ	No	No			
Bennett 1997	P&H *	AJPS	No	No			
Bennett and Stam 1996	P&H *	APSR	No	No			
Box-Steffensmeier 1996	P&H *	AJPS	No	No			
Box-Steffensmeier, Arnold and Zorn 1997	P&H *	APSR	No	No			
Cunningham 2011	P&H *	APSR	No	No			
Golder, Golder and Siegel 2012	P&H *	JOP	No	No			
Hartzell and Hoddie 2003	P&H *	AJPS	No	No			
Lyall 2010	P&H *	APSR	No	No			
Martin 2004	P&H *	AJPS	No	No			
Martin and Vanberg 2004	P&H *	AJPS	No	No			
Regan and Stam 2000	Authors' search	ISQ	No	No			
Berlinski, Dewan and Dowding 2010	P&H	JOP	Yes	No			
Box-Steffensmeier et al. 2003 (rep. of Bennett 1997: Weibull)	P&H	JCR	Yes	No			
Diermeier and Stevenson 1999	P&H *	AJPS	Yes	No			
Gibler and Tir 2010	P&H	AJPS	Yes	No			
Koch and Sullivan 2010	P&H	JOP	Yes	No			
Leeds and Savun 2007	P&H *	JOP	Yes	No			
Long, Nordstrom and Baek 2007	P&H *	JOP	Yes	No			
Mattes and Savun 2010	P&H *	AJPS	Yes	No			
Schleiter and Morgan-Jones 2009	P&H	APSR	Yes	No			
Senese and Quackenbush 2003	P&H *	JOP	Yes	No			
Balch-Lindsay, Enterline and Joyce 2008	Licht	JPR	Yes	Yes	TIC		No
Keele 2010 (rep. of Carpenter 2002: log-normal)	Keele	AJPS	Yes	Yes	TIC		No
Licht 2011 (rep. of BLEJ 2008)	Licht	JPR	Yes	Yes	TIC		No
Zhelyazkova and Torenvlied 2009	Authors' search	EUP	Yes	Yes	TIC		Yes
Chiozza and Goemans 2004	P&H /Keele *	AJPS	Yes	Yes	TVC	No	No
Debs and Goemans 2010	P&H *	APSR	Yes	Yes	TVC	No	No
Grieco 2001	Authors' search	ISQ	Yes	Yes	TVC	No	No
Keele 2010 (rep. of Chiozza and Goemans 2004)	Keele	AJPS	Yes	Yes	TVC	No	No
Golub and Steunenberg 2007	Licht	EUP	Yes	Yes	TVC	No	Yes
Licht 2011 (rep. of Golub and Steunenberg 2007)	Licht	JPR	Yes	Yes	TVC	No	Yes
Box-Steffensmeier et al. 2003 (rep. of Balch-Lindsay, Enterline 2001)	P&H	JCR	Yes	Yes	TVC	No	†
Box-Steffensmeier et al. 2003 (rep. of Werner 1999: Weibull)	P&H	JCR	Yes	Yes	TVC	No	†
Berry, Burden and Howell 2010	P&H	APS	Yes	Yes	TVC	Yes	Yes
Box-Steffensmeier and Zorn 2001	Keele	AJPS	Yes	Yes	TVC	Yes	Yes
Crescenzi 2007	P&H *	APSR	Yes	Yes	TVC	Yes	Yes
Keele 2010 (rep. of Box-Steffensmeier and Zorn 2001)	Keele	AJPS	Yes	Yes	TVC	Yes	Yes
Licht 2011 (rep. of Meinke 2005)	Licht	LSQ	Yes	Yes	TVC	Yes	Yes
Maeda 2010	P&H *	JOP	Yes	Yes	TVC	Yes	Yes
Maltzman and Shipan 2008	P&H	AJPS	Yes	Yes	TVC	Yes	Yes
Meinke 2005	Licht	LSQ	Yes	Yes	TVC	Yes	Yes
Murillo and Martinez-Gallardo 2007	P&H	AJPS	Yes	Yes	TVC	Yes	Yes

Notes: Box-Steffensmeier et al. 2003, Keele 2010 and Licht 2011 are counted three times because they each replicated three studies. P&H* indicates the study was replicated by Park and Hendry 2015. P&H without * indicates the study was in the P&H database of studies, but not replicated in P&H. † Lacking the replication data, the authors could not tell whether proper adjustments made in Box-Steffensmeier et al.'s (2003) replications of Werner (1999) and Bennett (1997), but from reading the original articles, the authors decided that most likely the time scales did not match in these two studies, suggesting they had the opportunity to implement the NPH correction inappropriately.

Table A2: Replication of Chiozza and Goemans (2004)

	Model 1			Model 2		
	b	std.err.	p-value	b	std.err.	p-value
Mixed regime	7.221	0.506	0.000	7.161	0.449	0.000
Mixed regime x ln(t)	−0.880	0.069	0.000	−0.874	0.063	0.000
Parliamentary democracy	5.339	0.546	0.000	5.279	0.515	0.000
Parliamentary democracy x ln(t)	−0.486	0.078	0.000	−0.481	0.076	0.000
Presidential democracy	5.300	0.601	0.000	5.313	0.603	0.000
Presidential democracy x ln(t)	−0.579	0.087	0.000	−0.583	0.089	0.000
Civil war	−0.046	0.449	0.918	−0.158	0.442	0.722
Civil war x ln(t)	0.127	0.070	0.071	0.145	0.069	0.037
Economic development	−1.201	0.105	0.000	−1.149	0.092	0.000
Economic development x ln(t)	0.158	0.015	0.000	0.150	0.014	0.000
Change in economic development	−0.004	0.001	0.007	−0.004	0.001	0.006
Trade openness	−0.079	0.025	0.002	−0.083	0.025	0.001
Change in trade openness	−0.001	0.001	0.068	−0.001	0.001	0.066
Population	3.692	0.253	0.000	3.579	0.094	0.000
Population x ln(t)	−0.538	0.038	0.000	−0.521	0.014	0.000
Age	0.253	0.017	0.000	0.249	0.011	0.000
Age x ln(t)	−0.036	0.003	0.000	−0.035	0.002	0.000
Previous times in office	−0.265	0.046	0.000	−0.268	0.046	0.000
Crisis involvement as chall.	−0.955	0.239	0.000	−1.040	0.249	0.000
Crisis involvement as target	−0.312	0.169	0.064	−0.373	0.174	0.032
War involvement as chall.	−4.139	1.440	0.005	−2.906	1.437	0.044
War involvement as chall. x ln(t)	0.500	0.211	0.020	0.287	0.220	0.192
War involvement as target	−0.222	0.207	0.284	−0.181	0.210	0.389
Win crisis	0.062	0.236	0.793			
Lose crisis	0.710	0.214	0.001			
Draw crisis	−0.058	0.225	0.796			
Win war	−0.043	0.500	0.931			
Lose war	1.062	0.280	0.000			
Draw war	−0.245	0.436	0.574			
Autocracy x Win crisis				−1.046	0.717	0.144
Autocracy x Lose crisis				1.373	0.365	0.000
Autocracy x Draw crisis				−1.134	0.603	0.060
Mixed reg. x Win crisis				0.048	0.400	0.905
Mixed reg. x Lose crisis				0.818	0.316	0.010
Mixed reg. x Draw crisis				−0.055	0.340	0.871
Parl. democ. x Win crisis				0.426	0.352	0.225
Parl. democ. x Lose crisis				0.391	0.409	0.338
Parl. democ. x Draw crisis				0.380	0.353	0.282
Pres. democ. x Win crisis				0.379	0.484	0.433
Pres. democ. x Lose crisis				0.152	0.663	0.819
Pres. democ. x Draw crisis				0.228	0.517	0.659
Autocracy x Win war				−0.454	0.982	0.644
Autocracy x Lose war				2.364	0.541	0.000
Autocracy x Draw war				−1.242	1.353	0.358
Mixed reg. x Win war				−1.221	2.328	0.600
Mixed reg. x Lose war				0.929	0.447	0.038
Mixed reg. x Draw war				−0.458	0.670	0.494
Parl. democ. x Win war				0.085	0.641	0.894
Parl. democ. x Lose war				0.521	0.431	0.227
Parl. democ. x Draw war				0.290	0.664	0.662
Pres. democ. x Win war				0.071	1.749	0.968
Pres. democ. x Lose war				1.035	1.038	0.319
Pres. democ. x Draw war				−0.019	1.655	0.991
No. of obs.	10,037			10,037		
No. of subjects	2,049			2,049		
No. of failures	1,828			1,828		
Log-likelihood	−10,125.385			−10,109.563		
Wald-test	107.553	0.000		101.379	0.000	
Theta	0.871			0.873		

Notes: We obtain coefficient estimates that are all about 80-100% larger than those reported in Chiozza and Goemens' (2004) paper, but with roughly the original standard errors. These results obtain using the authors' original replication data, Keele's (2010) replication data for his reanalysis of their results, or Park and Hendry's (2015) replication data reanalyzing the original results. We discussed this with the authors of the original paper and they obtained results similar to ours using the current version of suvival (2.40-1 from 2016-10-31) while also being able to replicate their original results using a previous version (survival_2.20 from 2005-09-30).

Table A3: Reanalysis of Chiozza and Goemans (2004)

	Model 1			Model 2		
	b	std.err.	p-value	b	std.err.	p-value
Mixed regime	0.129	0.282	0.648	0.173	0.284	0.542
Mixed regime x ln(t)	0.088	0.042	0.036	0.087	0.043	0.041
Parliamentary democracy	−0.344	0.339	0.310	−0.281	0.341	0.410
Parliamentary democracy x ln(t)	0.263	0.052	0.000	0.256	0.053	0.000
Presidential democracy	−2.701	0.469	0.000	−2.745	0.477	0.000
Presidential democracy x ln(t)	0.530	0.069	0.000	0.545	0.071	0.000
Civil war	1.020	0.310	0.001	0.962	0.312	0.002
Civil war x ln(t)	−0.044	0.049	0.364	−0.036	0.049	0.465
Economic development	−0.149	0.068	0.027	−0.151	0.068	0.026
Economic development x ln(t)	0.009	0.010	0.388	0.009	0.010	0.391
Change in economic development	−0.005	0.001	0.000	−0.005	0.001	0.000
Trade openness	−0.098	0.022	0.000	−0.099	0.022	0.000
Change in trade openness	−0.001	0.001	0.044	−0.001	0.001	0.037
Population	0.052	0.079	0.510	0.043	0.080	0.587
Population x ln(t)	−0.011	0.011	0.327	−0.009	0.011	0.424
Age	−0.015	0.009	0.107	−0.016	0.009	0.079
Age x ln(t)	0.005	0.001	0.001	0.005	0.001	0.000
Previous times in office	−0.160	0.048	0.001	−0.161	0.048	0.001
Crisis involvement as chall.	−0.745	0.228	0.001	−0.863	0.236	0.000
Crisis involvement as target	−0.012	0.161	0.939	−0.035	0.165	0.831
War involvement as chall.	−2.644	1.292	0.041	−2.241	1.241	0.071
War involvement as chall. x ln(t)	0.295	0.188	0.117	0.207	0.184	0.262
War involvement as target	−0.200	0.193	0.301	−0.183	0.201	0.361
Win crisis	−0.600	0.238	0.012			
Lose crisis	0.399	0.209	0.057			
Draw crisis	−0.751	0.219	0.001			
Win war	−1.064	0.527	0.043			
Lose war	1.568	0.261	0.000			
Draw war	−0.322	0.427	0.451			
Autocracy x Win crisis				−1.319	0.745	0.077
Autocracy x Lose crisis				1.251	0.352	0.000
Autocracy x Draw crisis				−1.174	0.542	0.030
Mixed reg. x Win crisis				−0.663	0.437	0.129
Mixed reg. x Lose crisis				0.282	0.314	0.369
Mixed reg. x Draw crisis				−0.733	0.343	0.032
Parl. democ. x Win crisis				−0.257	0.346	0.457
Parl. democ. x Lose crisis				−0.009	0.393	0.982
Parl. democ. x Draw crisis				−0.367	0.347	0.290
Pres. democ. x Win crisis				−0.450	0.458	0.325
Pres. democ. x Lose crisis				0.026	0.727	0.972
Pres. democ. x Draw crisis				−1.136	0.561	0.043
Autocracy x Win war				−1.389	1.029	0.177
Autocracy x Lose war				2.584	0.457	0.000
Autocracy x Draw war				−1.036	1.229	0.399
Mixed reg. x Win war				−4.029	3.064	0.189
Mixed reg. x Lose war				1.678	0.397	0.000
Mixed reg. x Draw war				−0.640	0.638	0.316
Parl. democ. x Win war				−0.314	0.640	0.624
Parl. democ. x Lose war				0.773	0.464	0.096
Parl. democ. x Draw war				0.660	0.649	0.310
Pres. democ. x Win war				−3.701	2.235	0.098
Pres. democ. x Lose war				2.331	0.971	0.016
Pres. democ. x Draw war				−0.197	1.597	0.902
No. of obs.	1,011,342			1,011,342		
No. of subjects	2,049			2,049		
No. of failures	1,828			1,828		
Log-likelihood	−11674.096			−11659.163		
Wald-test	17.659	0.000		11.137	0.000	
Theta	0.402			0.405		

Table A4: Replication and Reanalysis of Grieco (2001)

	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Interim Conflict	-22.352	5.271	0.000	-16.411	3.595	0.000
Defender Power Status	15.600	7.104	0.028	10.179	6.599	0.123
Defender Relative Capacity	11.553	3.159	0.000	3.931	1.707	0.021
Defender Capacity x Use	-12.329	3.324	0.000	-3.685	2.049	0.072
Defender Military Use	12.075	3.249	0.000	3.541	2.298	0.123
Challenger Capacity Change	1.050	1.724	0.543	-0.026	1.505	0.986
Challenger Territory	0.637	1.185	0.591	-0.500	0.799	0.532
Defender Conciliation	7.179	1.451	0.000	2.421	1.598	0.130
Defender Bullying	0.942	1.325	0.477	-0.040	1.047	0.970
Stalemate	7.367	2.650	0.005	-0.185	1.394	0.894
Compromise	6.858	2.508	0.006	0.733	1.358	0.589
Challenger Lost	4.814	2.284	0.035	-1.529	1.252	0.222
Challenger Severity	-0.243	2.264	0.914	-1.531	1.716	0.372
Challenger Democratic	2.569	1.693	0.129	-0.489	1.432	0.733
Defender Democratic	5.123	1.632	0.002	1.981	1.252	0.114
Defender Democratic x Challenger Severity	-4.423	2.633	0.093	-1.121	2.051	0.585
Challenger Turmoil	-5.368	6.576	0.414	-5.568	5.150	0.280
Defender Turmoil	4.528	2.601	0.082	1.044	1.928	0.588
ln(t) x Power Status	-1.957	1.042	0.060	-1.165	0.962	0.226
ln(t) x Relative Capacity	-1.509	0.390	0.000	-0.499	0.231	0.031
ln(t) x Defender Capacity x Use	1.595	0.412	0.000	0.443	0.278	0.111
ln(t) x Military Use	-1.555	0.400	0.000	-0.435	0.302	0.150
ln(t) x Challenger Capacity Change	-0.134	0.234	0.565	0.018	0.220	0.934
ln(t) x Challenger Territory	-0.027	0.154	0.860	0.128	0.109	0.238
ln(t) x Defender Conciliation	-0.953	0.208	0.000	-0.296	0.226	0.190
ln(t) x Defender Bullying	-0.110	0.182	0.544	0.025	0.146	0.866
ln(t) x Stalemate	-0.906	0.341	0.008	0.119	0.200	0.551
ln(t) x Compromise	-0.895	0.310	0.004	-0.070	0.190	0.712
ln(t) x Challenger Lost	-0.568	0.276	0.040	0.288	0.173	0.095
ln(t) x Challenger Severity	0.015	0.304	0.961	0.181	0.237	0.444
ln(t) x Interim Conflict	2.668	0.603	0.000	1.952	0.407	0.000
ln(t) x Challenger Democratic	-0.406	0.236	0.085	-0.016	0.201	0.938
ln(t) x Defender Democratic	-0.663	0.221	0.003	-0.253	0.180	0.159
ln(t) x Defender Democratic x Challenger Severity	0.612	0.348	0.079	0.168	0.278	0.544
ln(t) x Challenger Turmoil	0.678	0.823	0.410	0.691	0.644	0.283
ln(t) x Defender Turmoil	-0.512	0.361	0.157	-0.059	0.273	0.830
No. of Obs.	8,633			8,633		
No. of subjects	410			410		
No. of failures	164			164		
log-likelihood	-639.706			-690.387		
Wald-test	253.097	0.000		190.043	0.000	

Table A5: Replication and Reanalysis of Balch-Lindsay, Enterline and Joyce (2008) Government Victory Model

Government Victory	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Intervention Supporting Government	2.485	1.825	0.173	0.785	1.591	0.622
Intervention for Government x ln(t)	-0.625	0.273	0.022	-0.340	0.234	0.147
Intervention Supporting Opposition	-1.638	1.117	0.143	-1.301	1.077	0.227
Balanced Intervention	1.748	1.338	0.191	1.103	1.329	0.406
Separatist	0.871	1.052	0.408	-0.993	0.648	0.125
Separatist x ln(t)	-0.215	0.175	0.220	0.108	0.111	0.330
War Costs	108.679	204.693	0.595	-210.483	272.334	0.440
War Costs x ln(t)	-34.672	38.051	0.362	15.082	41.763	0.718
Gov. Reputation	-1.302	0.505	0.010	-1.413	0.502	0.005
Economic Development	0.958	0.151	0.000	0.184	0.081	0.024
Economic Development x ln(t)	-0.166	0.024	0.000	-0.040	0.015	0.006
Binary Measure of Democracy	0.331	0.328	0.312	0.359	0.337	0.286
No. of Obs.	924			924		
No. of subjects	213			213		
No. of failures	109			109		
log-likelihood	-427.884			-477.591		
Wald-test	80.537	0.000		41.283	0.000	

Table A6: Replication and Reanalysis of BLEJ (2008) Opposition Victory Model

Opposition Victory	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Intervention Supporting Government	1.925	1.631	0.238	0.554	1.060	0.601
Intervention for Government x ln(t)	-0.427	0.230	0.063	-0.183	0.138	0.185
Intervention Supporting Opposition	1.741	0.475	0.000	1.937	0.461	0.000
Balanced Intervention	-39.580	1.064	0.000	-39.953	1.008	0.000
Separatist	-0.097	1.710	0.955	-2.268	1.098	0.039
Separatist x ln(t)	-0.183	0.261	0.483	0.214	0.174	0.218
War Costs	171.246	62.883	0.006	16.984	25.054	0.498
War Costs x ln(t)	-33.554	11.804	0.004	-5.516	3.596	0.125
Gov. Reputation	-0.658	0.582	0.258	-0.575	0.609	0.345
Economic Development	0.928	0.217	0.000	0.132	0.154	0.393
Economic Development x ln(t)	-0.176	0.035	0.000	-0.043	0.028	0.123
Binary Measure of Democracy	-0.343	0.532	0.518	-0.355	0.570	0.534
No. of Obs.	924			924		
No. of subjects	213			213		
No. of failures	45			45		
log-likelihood	-174.446			-197.115		
Wald-test	4,985.616	0.000		5,438.560	0.000	

Table A7: Replication and Reanalysis of BLEJ (2008) Negotiated Settlement Model

Negotiated Settlement	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Intervention Supporting Government	5.673	3.791	0.135	2.569	2.440	0.292
Intervention for Government x ln(t)	-0.751	0.496	0.130	-0.345	0.313	0.271
Intervention Supporting Opposition	1.388	0.561	0.013	1.463	0.638	0.022
Balanced Intervention	-2.631	1.210	0.030	-2.738	1.250	0.028
Separatist	8.158	2.929	0.005	3.679	1.665	0.027
Separatist x ln(t)	-1.234	0.410	0.003	-0.601	0.246	0.014
War Costs	-211.754	158.261	0.181	-306.267	162.989	0.060
War Costs x ln(t)	25.080	20.397	0.219	36.988	20.848	0.076
Gov. Reputation	0.156	0.618	0.800	0.043	0.645	0.947
Economic Development	0.509	0.365	0.163	-0.087	0.221	0.695
Economic Development x ln(t)	-0.083	0.051	0.104	0.007	0.034	0.838
Binary Measure of Democracy	-1.194	1.216	0.326	-1.370	1.222	0.262
No. of Obs.	924			924		
No. of subjects	213			213		
No. of failures	40			40		
log-likelihood	-132.854			-141.870		
Wald-test	36.163	0.000		26.223	0.010	

Table A8: Replication and Reanalysis of Debs and Goemans (2010) Table 1

	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Democracy	0.191	0.273	0.484	−0.743	0.237	0.002
Democracy x ln(t)	0.014	0.042	0.746	0.165	0.037	0.000
Civil War	0.692	0.311	0.026	−0.189	0.268	0.480
Civil War x ln(t)	−0.055	0.047	0.236	0.084	0.041	0.038
GDP per capita	0.032	0.051	0.539	−0.036	0.048	0.451
GDP Growth	−2.535	0.356	0.000	−2.483	0.359	0.000
Trade Openness	0.340	0.708	0.631	−2.506	0.676	0.000
Trade Openness x ln(t)	−0.132	0.096	0.168	0.268	0.088	0.002
Change in Trade Open	−0.165	0.081	0.043	−0.137	0.083	0.098
Population	0.004	0.038	0.919	−0.008	0.033	0.797
Age	0.319	0.009	0.000	−0.005	0.009	0.574
Age x ln(t)	−0.046	0.001	0.000	0.004	0.001	0.005
Times in Office	−0.093	0.046	0.041	−0.060	0.046	0.190
Entry	3.856	0.266	0.000	1.193	0.229	0.000
Entry x ln(t)	−0.583	0.040	0.000	−0.183	0.036	0.000
Challenger	−0.762	0.222	0.001	−0.788	0.219	0.000
Target	0.013	0.145	0.926	−0.002	0.139	0.986
Inheritor	−0.345	0.244	0.157	0.077	0.234	0.743
Democracy Crisis Victory	−0.224	0.266	0.398	−0.377	0.270	0.162
Democracy Crisis Defeat	0.142	0.368	0.699	−0.185	0.390	0.635
Democracy Crisis Draw	−0.049	0.275	0.859	−0.597	0.285	0.036
Nondemocracy Crisis Victory	−0.865	0.357	0.015	−0.700	0.333	0.035
Nondemocracy Crisis Defeat	0.360	0.969	0.710	−0.818	1.029	0.427
Nondemocracy Crisis Defeat x ln(t)	−0.009	0.138	0.948	0.166	0.148	0.262
Nondemocracy Crisis Draw	−0.332	2.042	0.871	−3.437	1.899	0.070
Nondemocracy Crisis Draw x ln(t)	−0.051	0.275	0.854	0.351	0.254	0.166
Democracy War Victory	−0.478	0.557	0.391	−1.130	0.588	0.055
Democracy War Defeat	0.308	0.554	0.578	0.414	0.585	0.479
Democracy War Draw	0.647	0.510	0.205	0.889	0.511	0.082
Nondemocracy War Victory	−2.780	1.204	0.021	−2.647	1.118	0.018
Nondemocracy War Defeat	0.775	0.358	0.031	1.085	0.329	0.001
Nondemocracy War Draw	−0.638	0.622	0.305	−0.887	0.608	0.144
No. of Obs.	9,424			862,047		
No. of subjects	1,860			1,860		
No. of failures	1,698			1,698		
log-likelihood	-9,728.148			-10,664.26		
Theta	0.395			0.234		

Table A9: Replication and Reanalysis of Debs and Goemans (2010) Table 3

	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Civilian	−0.057	0.131	0.662	−0.069	0.128	0.591
Monarch	−0.312	0.302	0.302	−0.301	0.282	0.285
Civil War	0.466	0.133	0.000	0.494	0.131	0.000
GDP per capita	1.730	0.269	0.000	0.198	0.202	0.327
GDP per capita x ln(t)	−0.242	0.038	0.000	−0.017	0.029	0.546
Growth	−2.743	0.572	0.000	−2.699	0.548	0.000
Trade Openness	−0.212	0.231	0.358	−0.421	0.238	0.077
Change in Trade Openness	−0.170	0.121	0.160	−0.190	0.117	0.104
Population	−0.013	0.050	0.795	−0.044	0.046	0.341
Age at Entry	0.035	0.005	0.000	0.032	0.005	0.000
Manner of Entry	5.140	0.468	0.000	1.023	0.334	0.002
Entry x ln(t)	−0.724	0.066	0.000	−0.126	0.049	0.010
Times in Office	−0.198	0.121	0.101	−0.200	0.122	0.100
Challenger	−1.784	0.418	0.000	−1.854	0.423	0.000
Target	−0.138	0.266	0.604	−0.126	0.262	0.631
Inheritor	0.118	0.424	0.780	−0.050	0.442	0.910
Military Crisis Victory	−0.906	0.652	0.165	−0.891	0.650	0.171
Military Crisis Defeat	1.042	0.623	0.094	1.171	0.616	0.057
Military Crisis Draw	−0.396	0.617	0.521	−0.584	0.603	0.333
Military War Victory	−8.928	6.219	0.151	−8.508	5.945	0.152
Military War Defeat	2.220	0.555	0.000	2.261	0.554	0.000
Military War Draw	0.175	0.838	0.835	−0.050	0.833	0.952
Civilian Crisis Victory	−0.688	0.626	0.272	−0.519	0.605	0.391
Civilian Crisis Defeat	0.264	0.470	0.575	0.516	0.485	0.287
Civilian Crisis Draw	−1.060	0.509	0.037	−0.912	0.497	0.066
Civilian War Victory	−3.299	2.237	0.140	−3.075	2.242	0.170
Civilian War Defeat	1.776	0.684	0.009	2.575	0.654	0.000
Civilian War Draw	−1.695	2.069	0.413	−2.191	2.213	0.322
Monarch Crisis Victory	−2.336	2.285	0.307	−2.604	2.226	0.242
Monarch Crisis Defeat	0.870	1.673	0.603	0.879	1.650	0.594
Monarch Crisis Draw	0.201	1.592	0.899	0.189	1.531	0.902
Monarch War Victory	−2.023	3.961	0.610	−1.565	3.480	0.653
Monarch War Defeat	2.840	1.035	0.006	2.788	1.017	0.006
Monarch War Draw	0.327	1.548	0.833	0.196	1.552	0.900
No. of Obs.	4,145			119,380		
No. of subjects	602			602		
No. of failures	525			525		
log-likelihood	-2,638.7			-2,724.4		
Theta	0.267			0.180		

Table A10: Replication and Reanalysis of Keele (2010) Table 7, Model 1

	Replication			Reanalysis		
	b	std.err.	p-value	b	std.err.	p-value
Incidence of primary indication (per 1000)	-0.001	0.001	0.075	-0.001	0.001	0.064
Primary indication is lethal confition	0.108	0.238	0.651	-0.035	0.226	0.878
Death rate, primary indication	0.382	0.252	0.130	0.670	0.249	0.007
Primary indication is acute confition	0.479	0.233	0.040	0.171	0.216	0.426
Primary indication results in hospitalization	0.129	0.273	0.637	-0.111	0.256	0.665
Millions of hospitalization associated with indication1	-0.508	0.544	0.350	-0.277	0.518	0.593
Millions of hospitalization associated with indication2	-0.949	0.714	0.184	-0.486	0.681	0.475
Millions of hospitalization associated with indication3	-1.351	0.718	0.060	-0.673	0.673	0.318
Millions of hospitalization associated with indication4	-1.437	0.727	0.048	-0.881	0.662	0.183
Millions of hospitalization associated with indication5	-1.089	0.795	0.171	-1.169	0.703	0.097
Millions of hospitalization associated with indication6	-0.438	0.932	0.638	-1.467	0.811	0.071
Millions of hospitalization associated with indication7	0.284	1.312	0.829	-1.742	1.167	0.136
Average length of hospitalizations	0.202	0.061	0.001	0.097	0.048	0.043
Average length of hospitalizations x ln(t)	-0.059	0.021	0.005	-0.034	0.015	0.028
Disease mainly affects men	0.317	0.398	0.426	0.251	0.375	0.503
Disease mainly affects women	0.353	0.383	0.357	0.930	0.344	0.007
Disease mainly affects children	-0.014	1.634	0.993	-2.767	1.784	0.121
Disease mainly affects children x ln(t)	0.253	0.475	0.593	0.858	0.513	0.095
Orphan drug	0.651	0.690	0.346	-0.209	0.662	0.752
Orphan drug x ln(t)	-0.197	0.236	0.408	0.288	0.224	0.199
National and regional groups	-0.011	0.009	0.233	-0.027	0.008	0.001
National and regional groups-squared	0.000	0.000	0.331	0.000	0.000	0.005
Nightly TV news disease stories	0.016	0.015	0.279	-0.012	0.015	0.440
Washington Post disease stories	-0.004	0.002	0.024	0.004	0.001	0.002
Days of congressional hearings on disease	0.084	0.019	0.000	0.016	0.022	0.472
Order of disease market entry for drug	-0.007	0.008	0.413	-0.014	0.008	0.095
FDA drug review staff (full time employees)	0.035	0.001	0.000	0.006	0.001	0.000
FDA drug review staff (full time employees) x ln(time)	-0.012	0.001	0.000	-0.001	0.000	0.007
No. of Obs.	408			50,054		
No. of subjects	408			408		
No. of failures	262			262		
log-likelihood	-710.491			-1,302.814		
Theta	0.807			0.826		

Figure A6: Interpreting the Interaction Results: Chiozza and Goemans (Model 1)
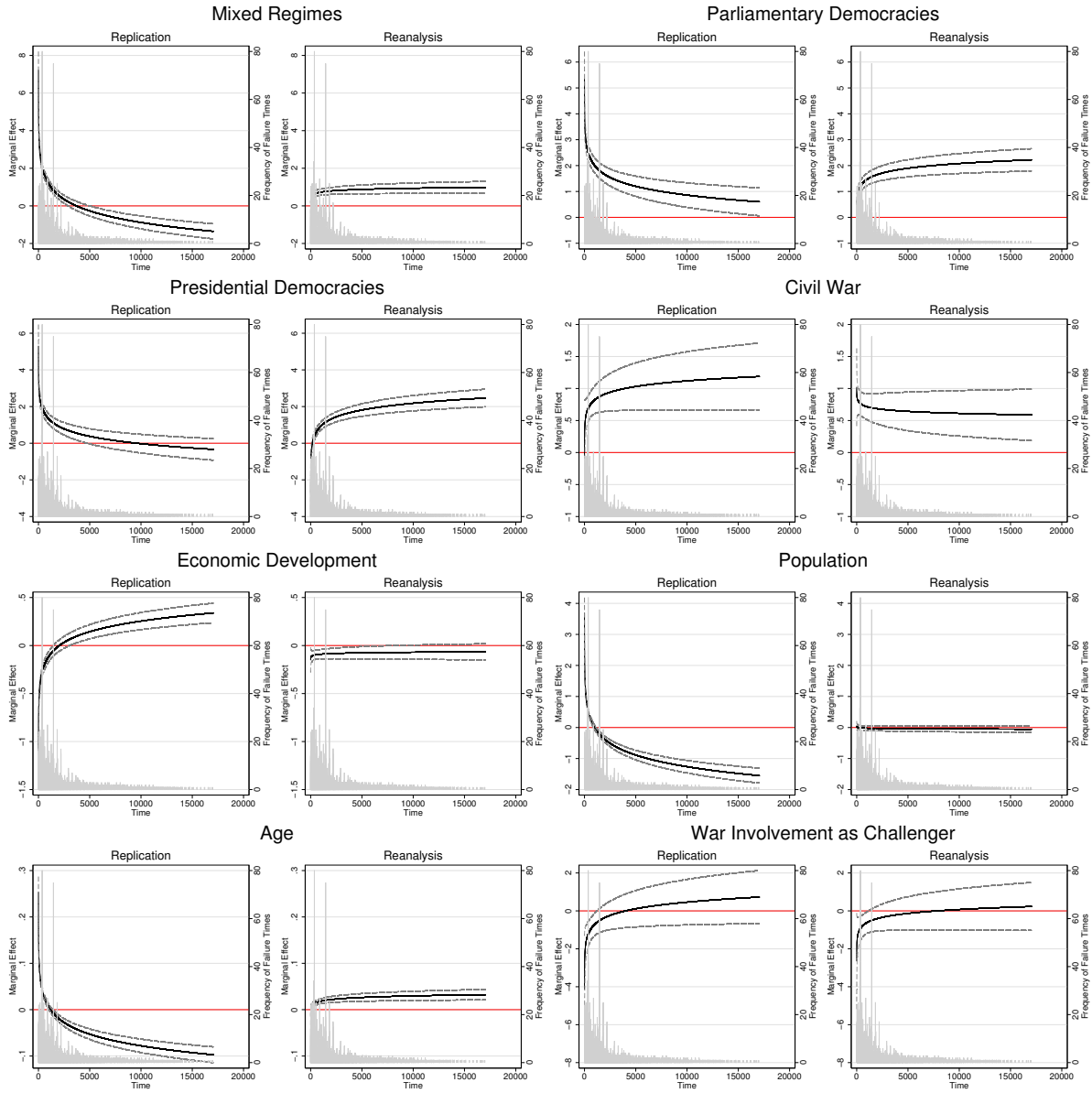
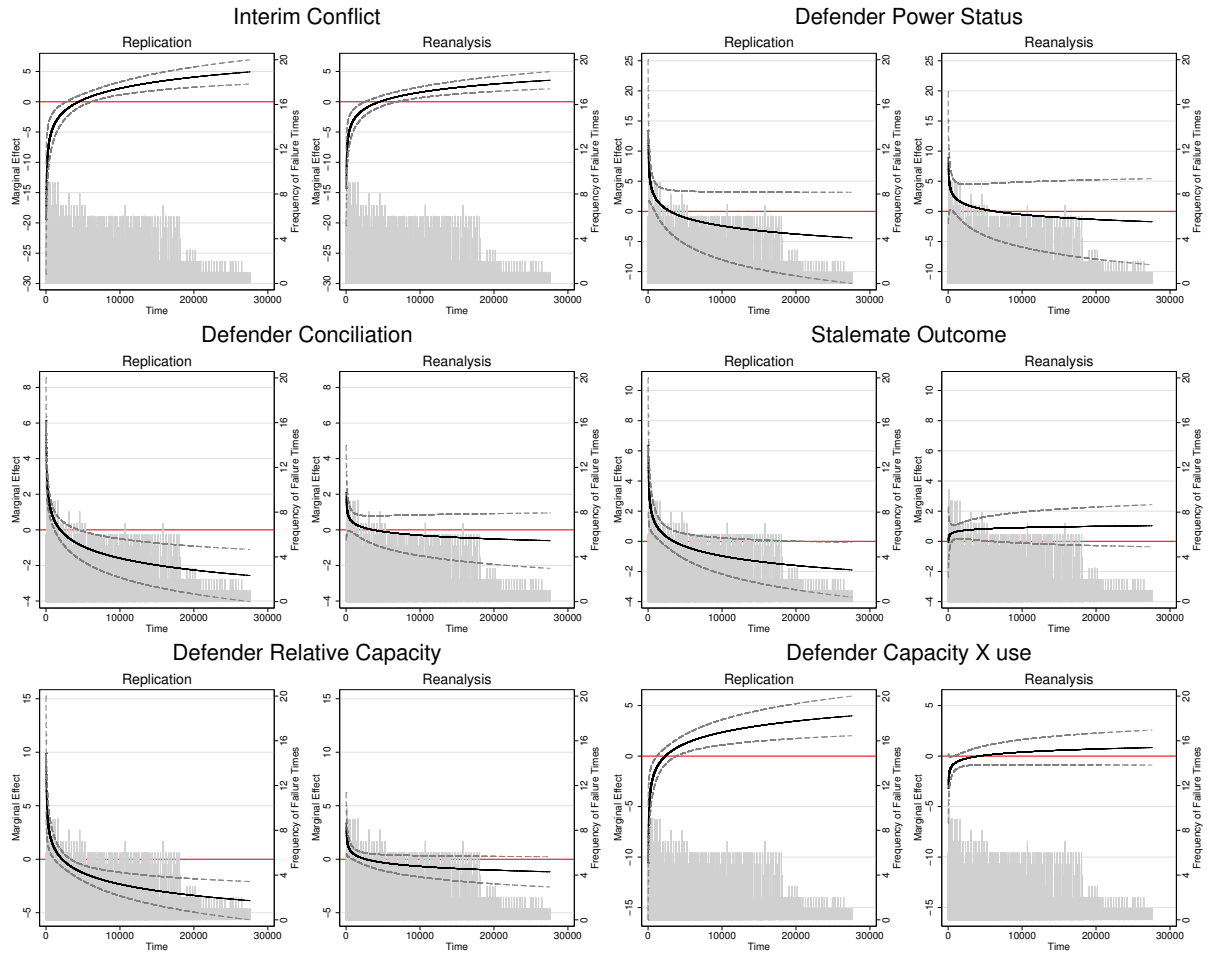# Figure A7: Interpreting the Interaction Results: Grieco

Figure A8: Interpreting the Interaction Results: Grieco (continued)
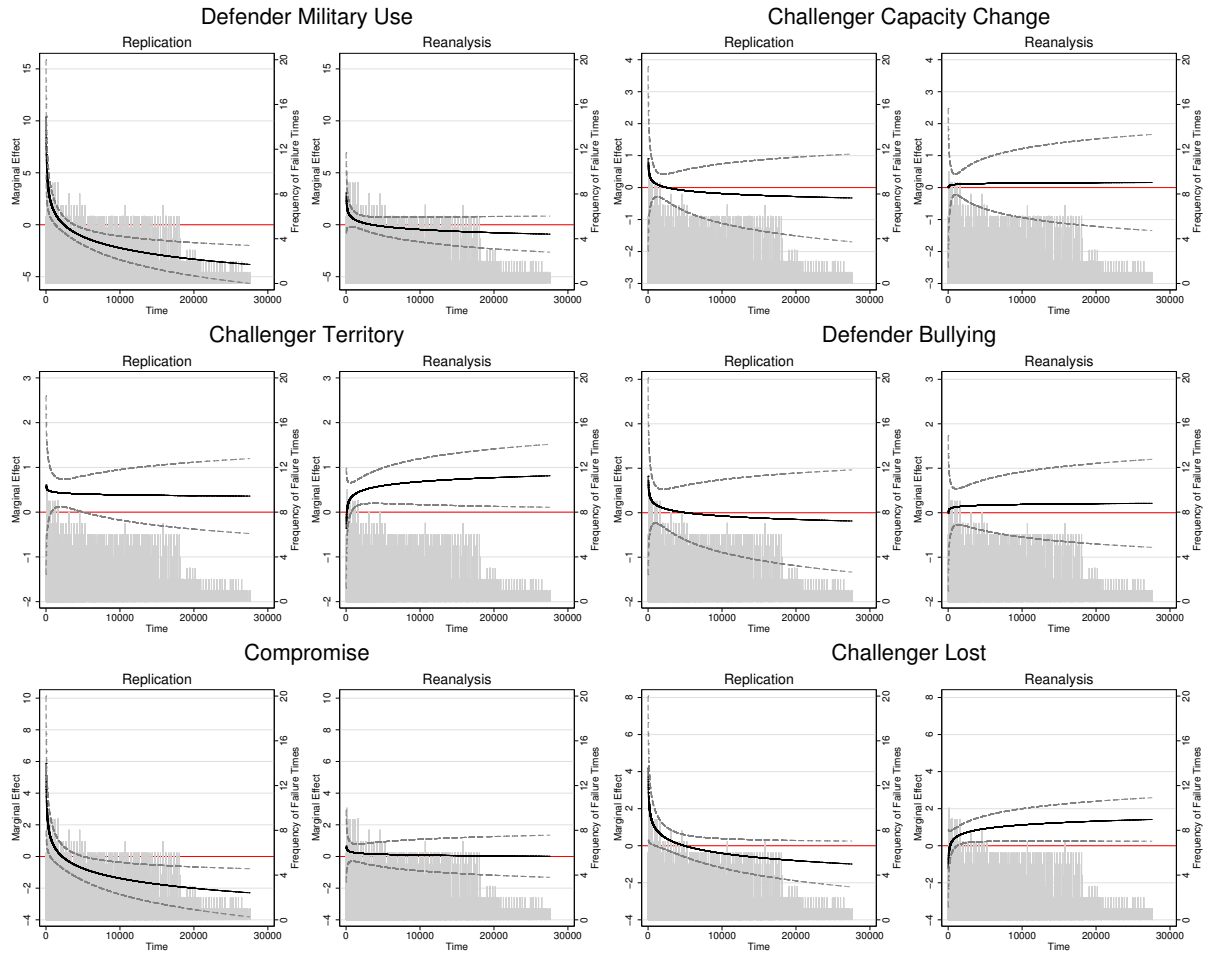
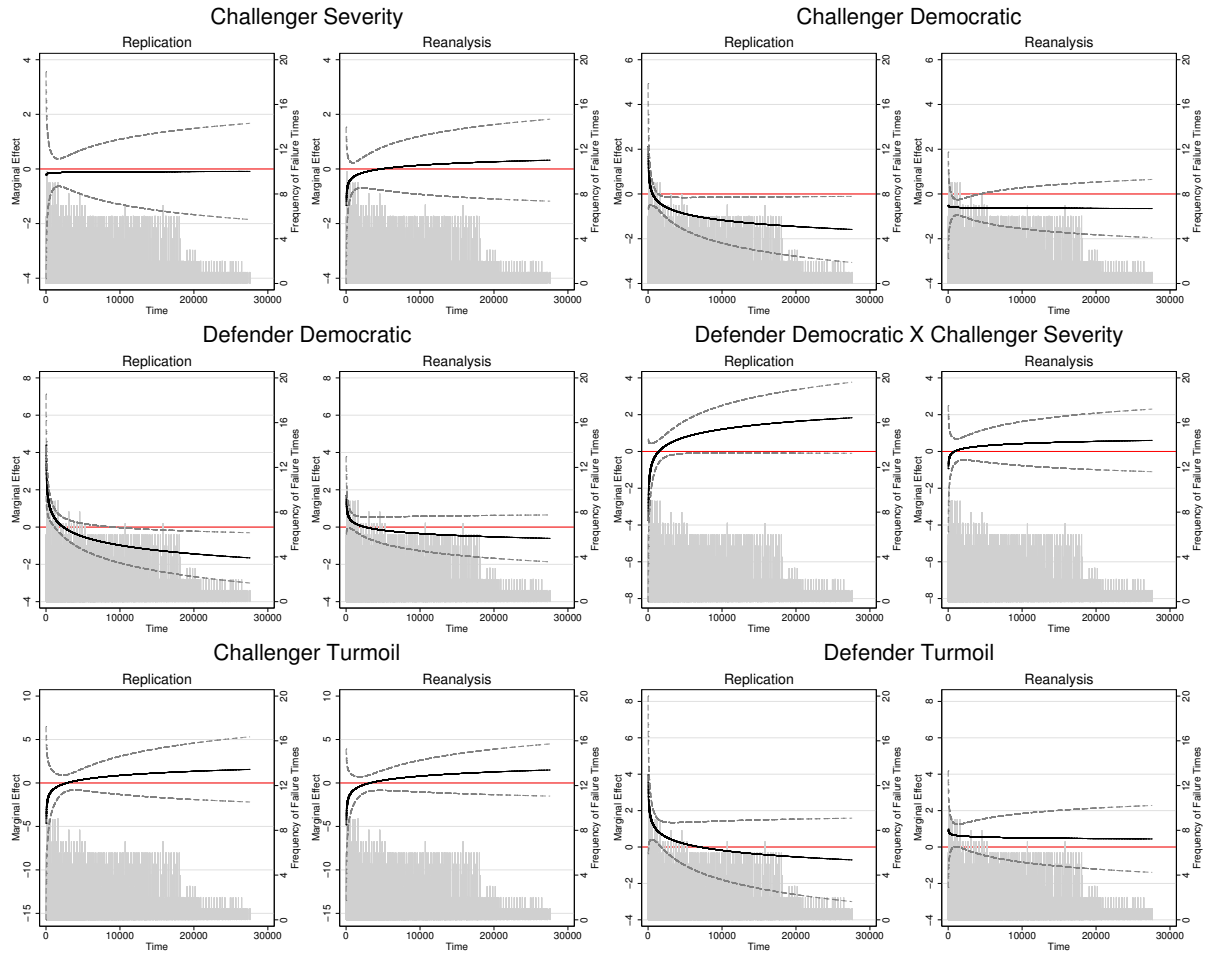Figure A9: Interpreting the Interaction Results: Grieco (continued)

Figure A10: Interpreting the Interaction Results: BLEJ (Government Victory Model)
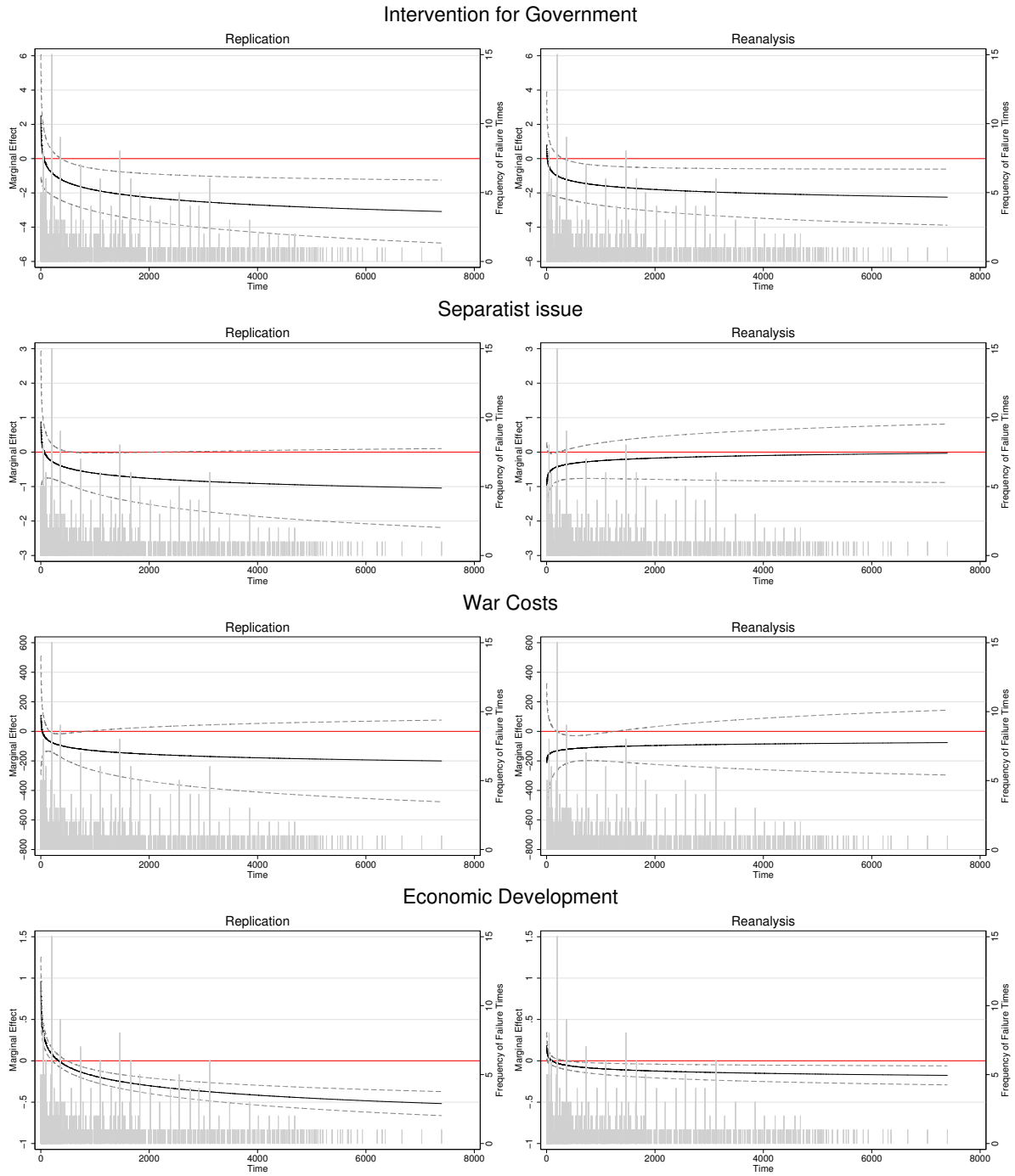
Intervention for Government

Separatist issue

War Costs

Economic Development

Figure A11: Interpreting the Interaction Results: BLEJ (Opposition Victory Model)

Intervention for Government

Separatist issue

War Costs

Economic Development

21
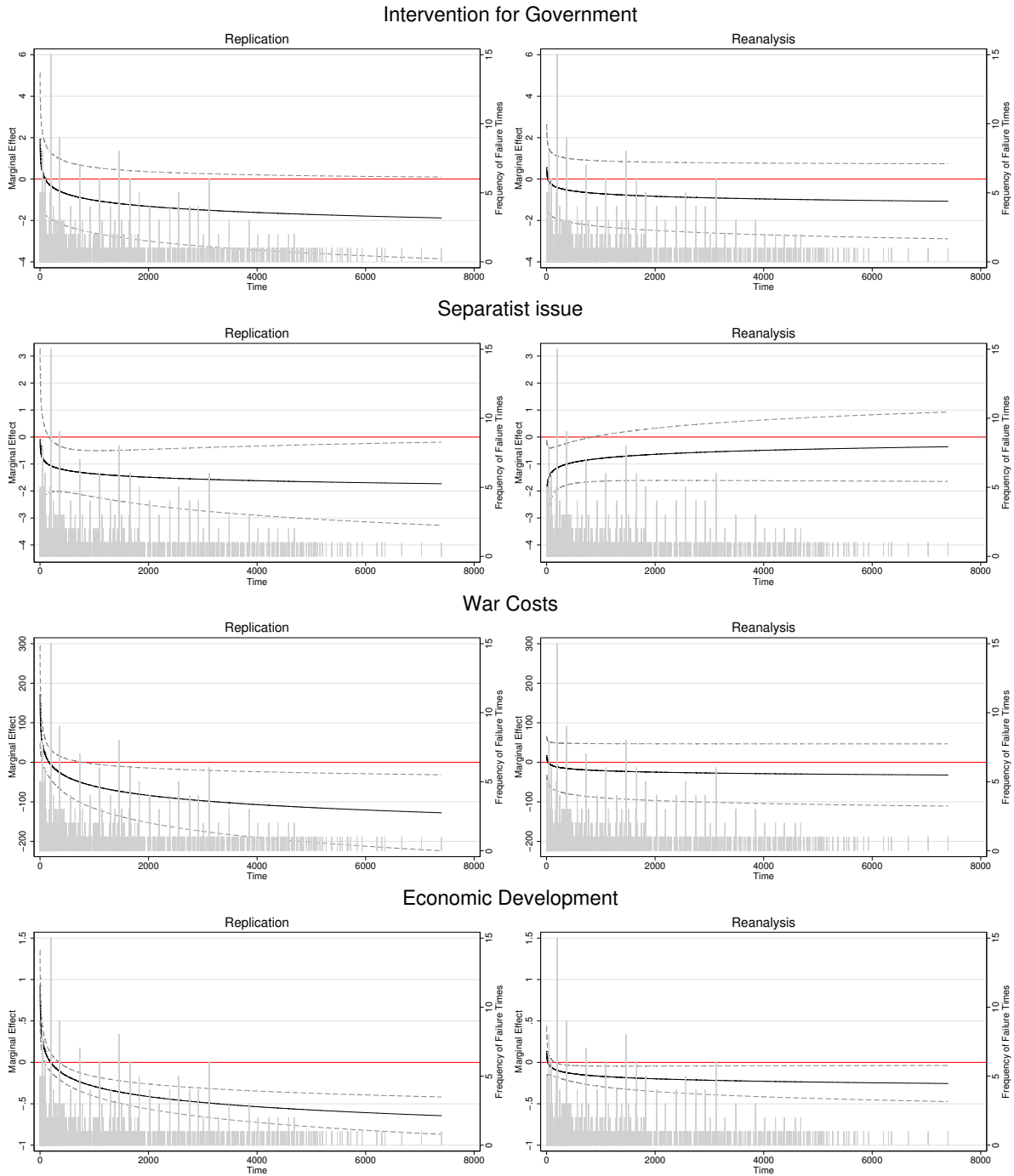
Figure A12: Interpreting the Interaction Results: BLEJ (Negotiated Settlement Model)
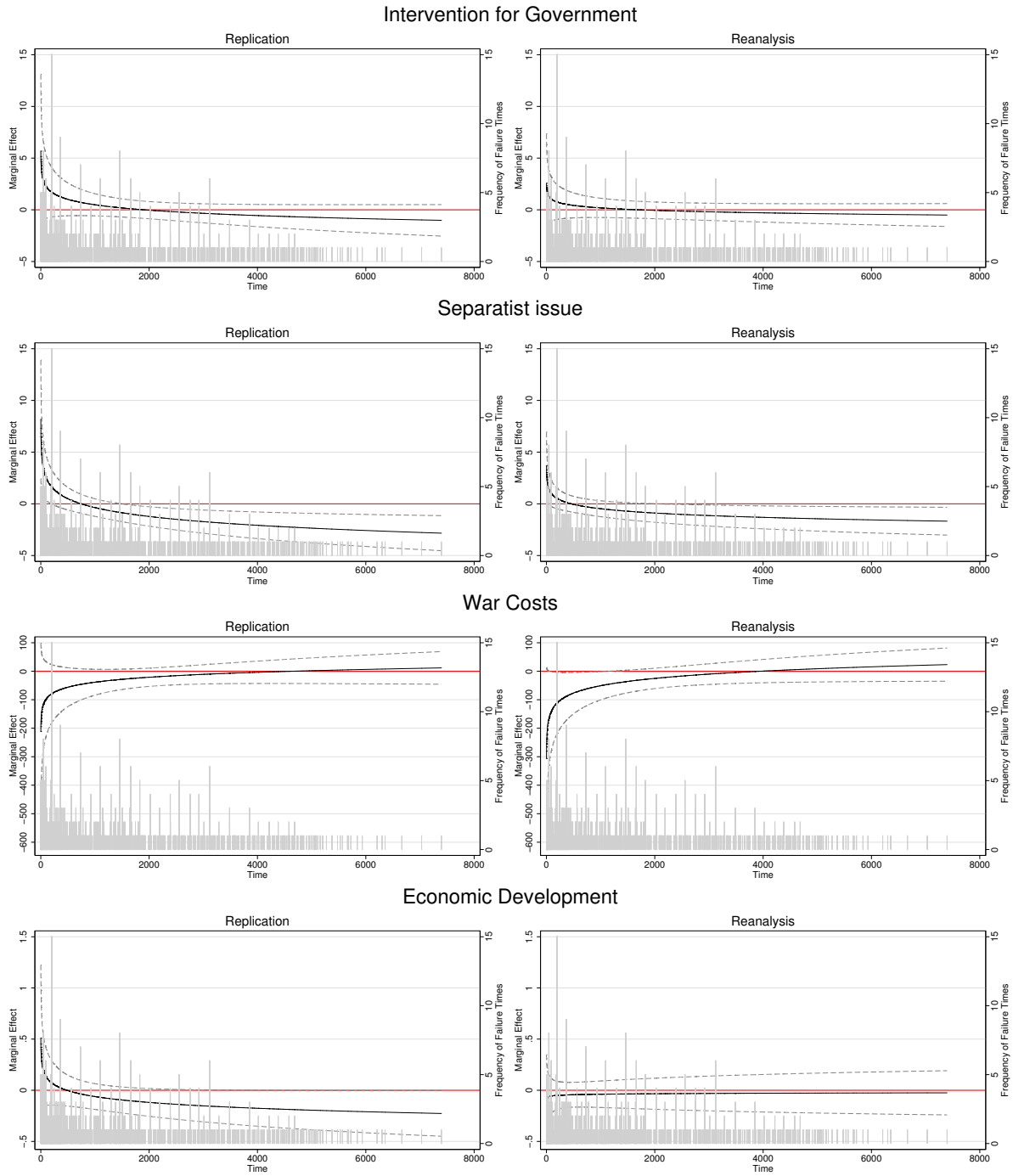
Figure A13: Interpreting the Interaction Results: Debs and Goemans (Table 1)

Democracy

Civil War

Trade Openness

Age
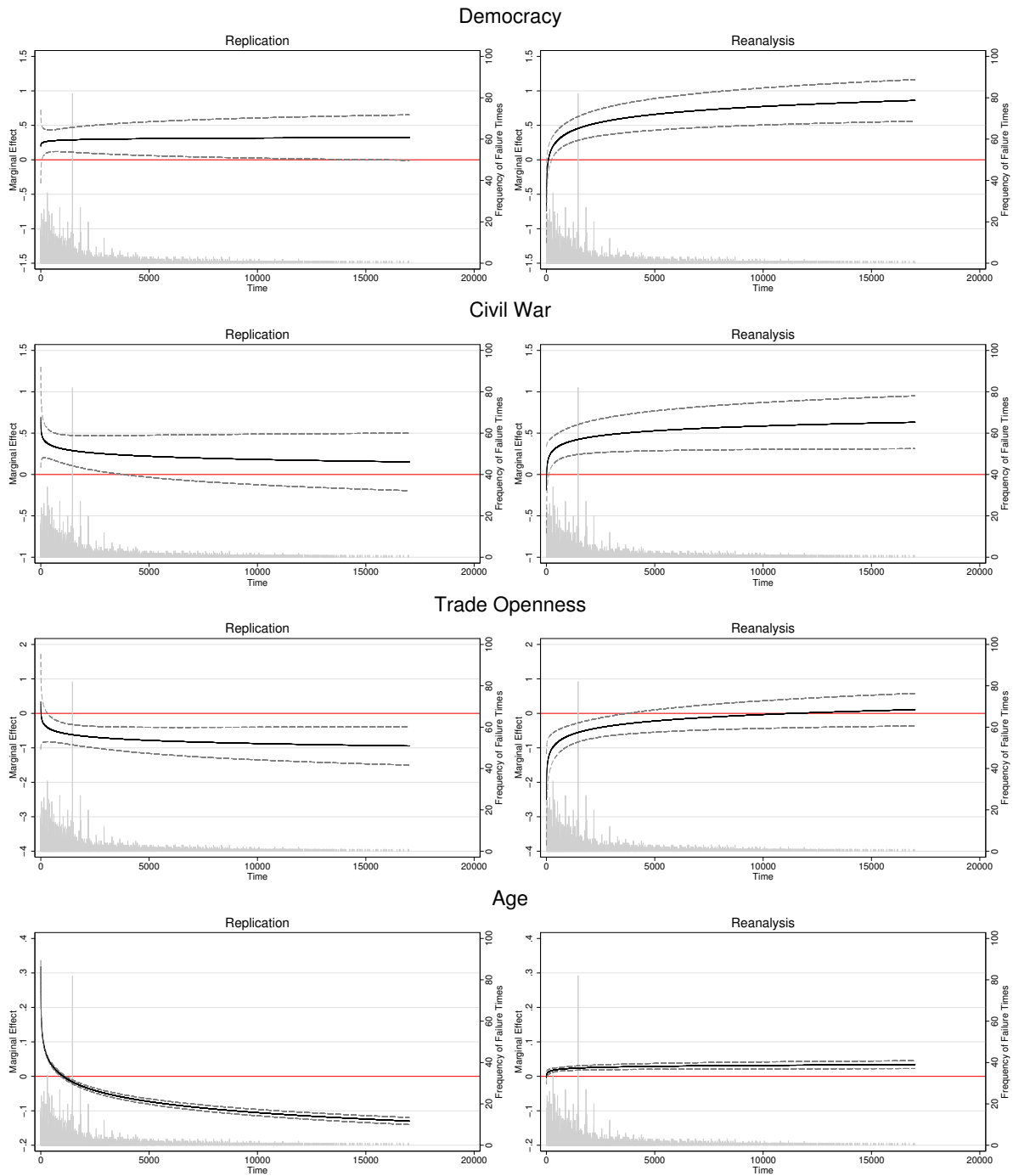
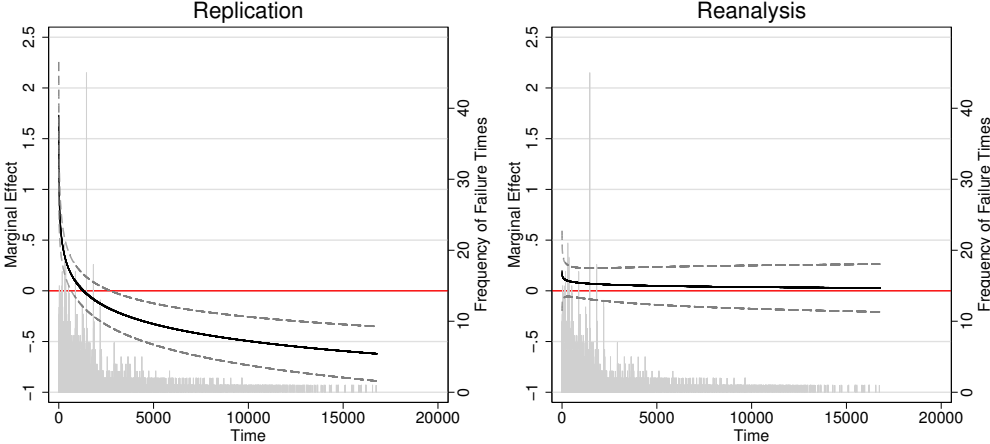Figure A14: Interpreting the Interaction Results: Debs and Goemans (Table 1, continued)
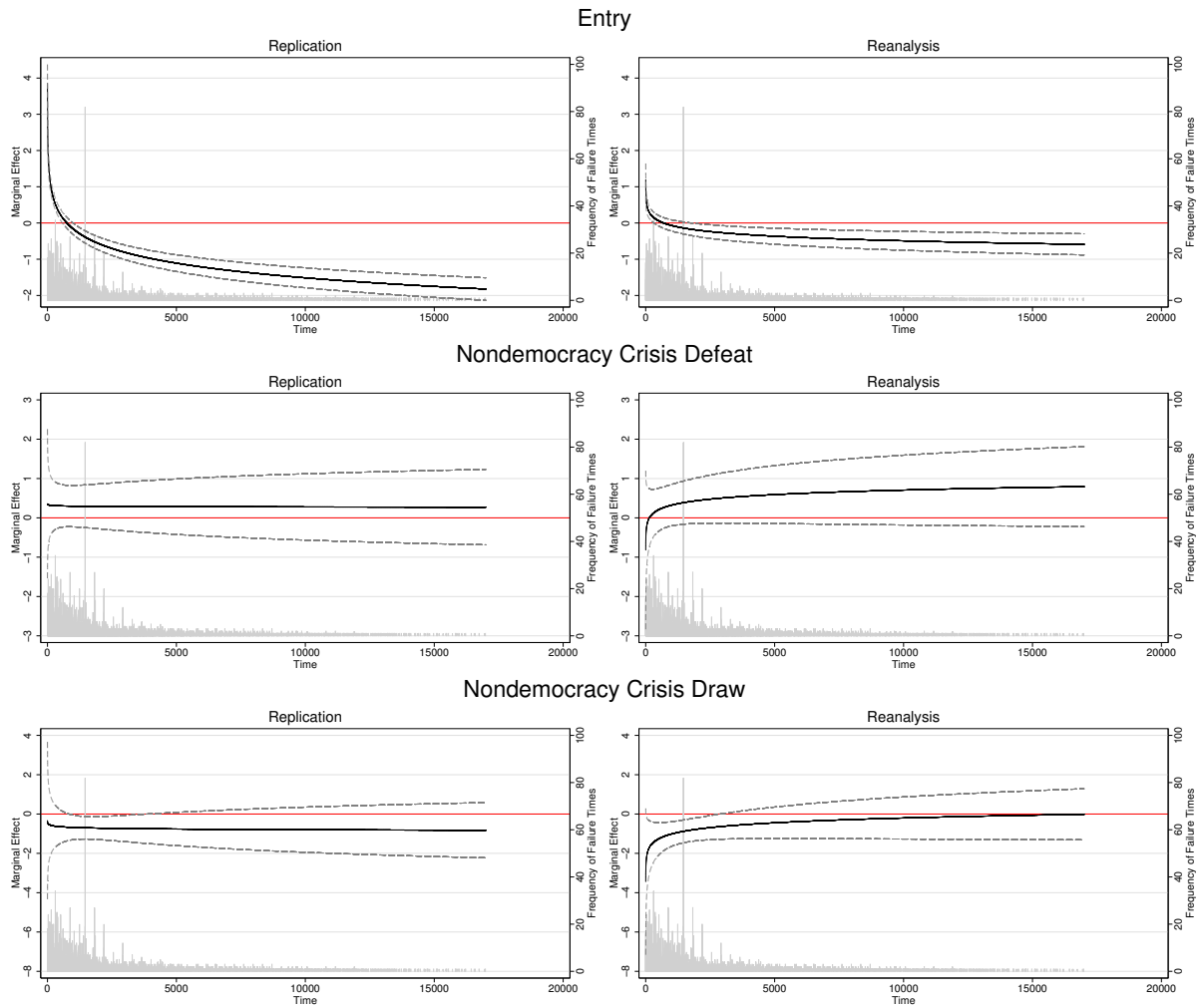
Figure A15: Interpreting the Interaction Results: Debs and Goemans (Table 3)

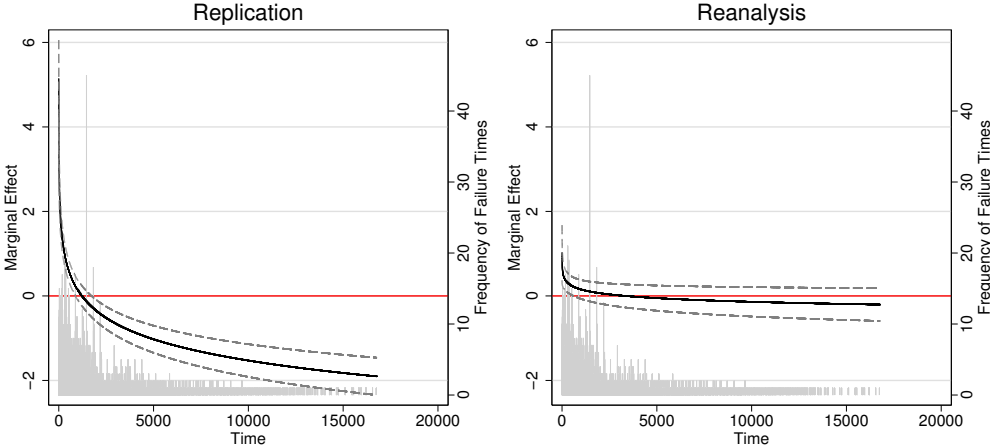## GDP per capita

Irregular or Forcible Entry

Figure A16: Interpreting the Interaction Results: Keele (Table 7, Model 1)