# Online Appendix to "Authoritarian Reversals and Democratic Consolidation"

## A.1 Complete estimation results for models with covariates

Complete estimation results for models with covariates are presented in Tables 1 and 2.

## A.2 Presidentialism and Democratic Consolidation

My estimation results suggest that it is practically impossible for presidential democracies to consolidate. A plausibility test of this particular finding would be to examine the survival of long-lived democracies across presidential and non-presidential systems. Consider, for instance, democracies that survived for at least 20 years (a period after which we may be fairly confident about the stability of a democracy): There have been 12 presidential democracies that survived for at least 20 years, and among these, four eventually reverted to dictatorship. In contrast, among the 45 non-presidential democracies that survived for at least 20 years, only six eventually reverted to dictatorship. Thus among all democracies that have survived for at least 20 years, *the hazard rate of a reversal is three times greater for presidential democracies than for non-presidential ones.*

Now consider the following question: "Suppose you observe a democracy in its twenty-first year. Is this democracy surviving a) because it is consolidated or b) because it is a transitional democracy that has simply been lucky? Knowing the different survival rates among long-lived presidential and long-lived non-presidential democracies, our answer to this question should depend on the type of executive in that democracy. Because very few parliamentary democracies revert after the age of 20 years, we can be fairly confident that such a democracy in its twenty-first year is surviving because it is consolidated. However, we can hardly have the same confidence for presidential democracies: Despite having survived for at least 20 years, one in three presidential democracies nonetheless reverts to dictatorship. This, in fact, is the kind of statistical inference that the split-population model conducts in the paper, while also controlling for covariates other than executive type and without being based on an arbitrary assumption about when to consider a democracy "long-lived." This simple plausibility test thus indicates that the results concerning the chances of consolidation for presidential democracies may not be very surprising after all.

## A.3 Some Additional Goodness-of-fit Diagnostics

Unfortunately, I could not include all of the goodness-of-fit diagnostics I conducted in the paper because of space constraints. In the paper, I compute AIC scores and likelihood ratio tests in order to compare the fit of the simple survival model and the alternative split-population models with and without frailty. (The likelihood ratio test statistic was appropriately modified to test boundary hypotheses.) Here, I reproduce those diagnostics that I ultimately excluded from the final version. I follow the discussion of goodness-of-fit analysis for parametric models in Box-Steffensmeier and Jones (2004) and its applications in the context of split-population models by Forster and Jones (2001) and Yamaguchi (1992).

I plot the distribution of survival time implied by the Weibull and log-logistic parameterizations of the split-population model against the empirical distribution of survival time obtained by the non-parametric Kaplan-Meier estimator. As can be seen in Figure 1 in this letter, both models provide a very reasonable fit to the data. We can also see that the non-parametric Kaplan-Meier estimate of the distribution function plateaus well below one, which is good indicator that a split-population model is appropriate.

I also examined the cumulative Cox-Snell residuals in order to assess the goodness-of-fit of the Weibull and log-logistic parameterizations for the reversal model. In the context of the split-population model, this can only be done by restricting attention to those observations that actually fail – that is, to only those democracies that are certainly transitional. Thus in a sample with a large proportion of both short-lived and long-lived right-censored observations, an analysis of Cox-Snell residuals should be interpreted with care since it excludes a large fraction of the data.

Figure 2 below plots the cumulative Cox-Snell residuals against the non-parametric Kaplan-Meier estimate of the cumulative hazard function. If the model fits the data well, cumulative Cox-Snell residuals will resemble an exponentially distributed random variable. A plot of the non-parametric estimate of the cumulative hazard function should therefore lie on the 45 degree line through the origin. The top portion of Figure 2 compares the Weibull and log-logistic parameterizations based on the analysis without covariates, while the bottom portion of Figure 2 compares the Weibull and log-logistic parameterizations based on the analysis with covariates. Both parameterizations provide a very reasonable fit, although the Weibull parameterization seems to provide a better fit in the analysis with covariates. (However, see the AIC comparisons in the paper that lead me to ultimately favor the log-logistic parameterization.)

## References

Box-Steffensmeier, Janet M. and Bradford S. Jones. 2004. *Event History Modeling.* New York: Cambridge University Press.

Forster, Martin and Andrew M. Jones. 2001. "The Role of Tobacco Taxes in Starting and Quitting Smoking: Duration Analysis of British Data." *Journal of the Royal Statistical Society* 164:517–547.

Yamaguchi, Kazuo. 1992. "Accelerated failure-time regression models with a regression model of surviving fraction: An application to the analysis of 'permanent unemployment' in Japan." *Journal of the American Statistical Association* 87(418):284–92.

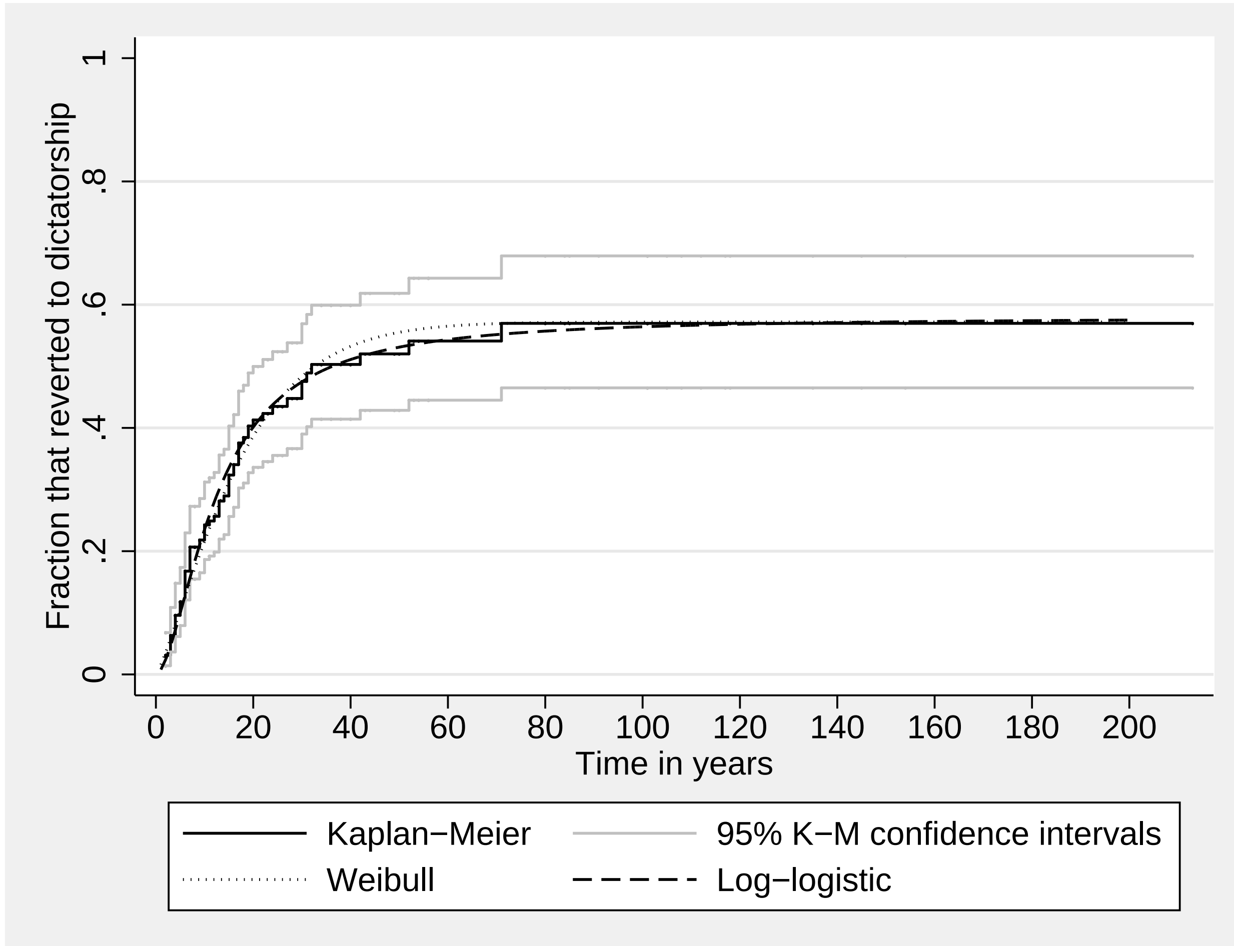


Figure 1: Relative fit of the Weibull and the log-logistic split-population survival models.

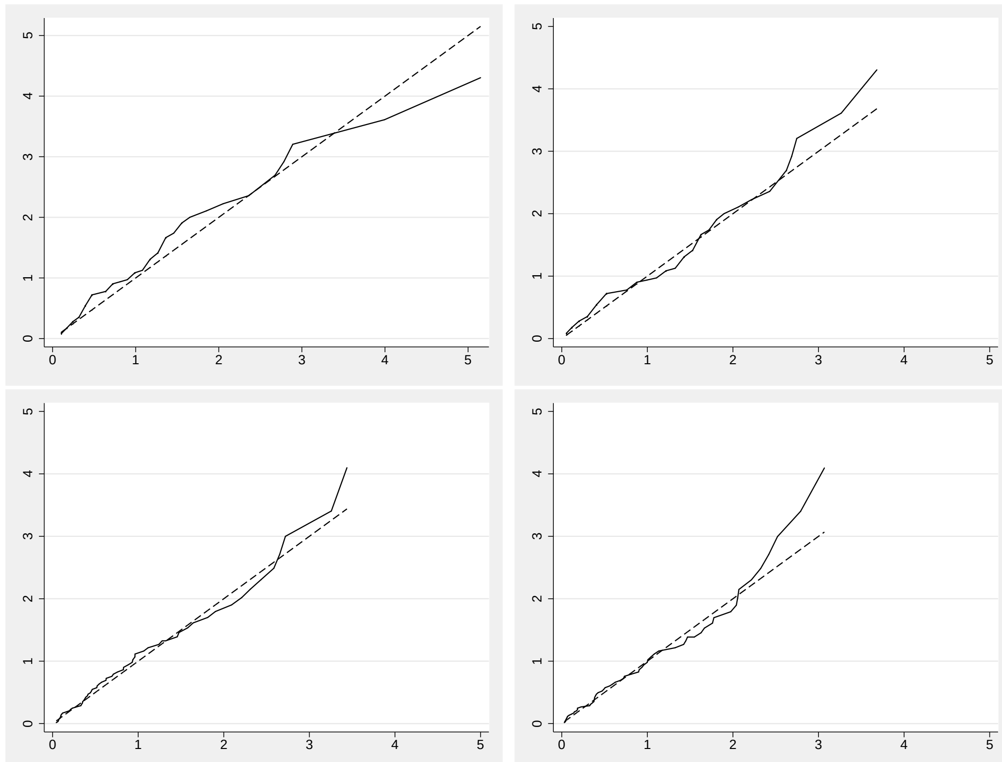


Figure 2: Cumulative Cox-Snell residuals, Weibull (left) and log-logistic (right) parameterizations based on the analysis without covariates (top) and with covariates (bottom).

Table 1: Estimation results for covariate models with Weibull parameterization.

| | | Split-population | | |
|---|---|---|---|---|
| **Parameter estimates** | **Simple Survival** | **No Frailty** | **Gamma Frailty** | **Inv. Gaussian Frailty** |
| Reversal model[a] | | | | |
| *GDP per capita* | 0.346*** | 0.117* | 0.089 | 0.081 |
| | (0.062) | (0.070) | (0.087) | (0.069) |
| *GDP growth* | 0.036*** | 0.041*** | 0.046*** | 0.044*** |
| | (0.014) | (0.013) | (0.017) | (0.014) |
| *Parliamentary* (vs. *Mixed*) | -0.009 | -0.246 | -0.305 | -0.348 |
| | (0.341) | (0.318) | (0.325) | (0.320) |
| *Presidential* (vs. *Mixed*) | -0.085 | 0.370 | 0.388 | 0.336 |
| | (0.323) | (0.308) | (0.289) | (0.312) |
| *Military* (vs. *Not independent*) | -0.963*** | -0.307 | -0.300 | -0.329 |
| | (0.317) | (0.274) | (0.336) | (0.295) |
| *Civilian* (vs. *Not independent*) | -0.118 | 0.077 | 0.130 | 0.087 |
| | (0.319) | (0.314) | (0.350) | (0.328) |
| *Monarchy* (vs. *Not independent*) | -0.233 | 0.979** | 0.931* | 1.018** |
| | (0.505) | (0.454) | (0.534) | (0.503) |
| *Intercept* | 2.981*** | 2.589*** | 2.290*** | 2.054*** |
| | (0.400) | (0.379) | (0.407) | (0.532) |
| *Shape parameter* $\alpha$ | 1.282*** | 1.457*** | 2.002*** | 2.356*** |
| | (0.133) | (0.151) | (0.547) | (0.500) |
| *Frailty variance* $\theta^c$ | — | — | 1.134* | 7.643** |
| | | | (1.436) | (9.575) |
| Consolidation model[b] | | | | |
| *GDP per capita* | — | 2.045*** | 2.136*** | 2.064*** |
| | | (0.555) | (0.607) | (0.544) |
| *GDP growth* | — | -0.048 | -0.009 | -0.015 |
| | | (0.246) | (0.227) | (0.219) |
| *Parliamentary* (vs. *Mixed*) | — | 2.290 | 2.226 | 2.330 |
| | | (2.326) | (2.223) | (2.226) |
| *Presidential* (vs. *Mixed*) | — | -8.186** | -8.336** | -7.939** |
| | | (4.035) | (3.979) | (3.815) |
| *Military* (vs. *Not independent*) | — | -3.985** | -4.070** | -4.006** |
| | | (1.857) | (1.906) | (1.837) |
| *Civilian* (vs. *Not independent*) | — | -0.549 | -0.403 | -0.492 |
| | | (1.067) | (1.115) | (1.057) |
| *Monarchy* (vs. *Not independent*) | — | -14.673 | -19.530 | -15.187 |
| | | (680.185) | (2704.040) | (978.060) |
| *Intercept* | — | -5.920** | -6.195** | -6.028** |
| | | (2.644) | (2.693) | (2.557) |

Note: Standard errors in parentheses. Significance levels *10%, **5%, ***1%.

[a]Model estimates the timing of reversals among transitional democracies via an exponential link function for the scale parameter $\lambda$.

[b]Model estimates $\pi$, the probability that a democracy is consolidated, via a logistic link function.

[c]Significance levels are based on the $\frac{1}{2}\chi^2_0 + \frac{1}{2}\chi^2_1$ likelihood ratio test statistic.

Table 2: Estimation results for covariate models with log-logistic parameterization.

| | | **Split-population** | | |
|---|---|---|---|---|
| **Parameter estimates** | **Simple Survival** | **No Frailty** | **Gamma Frailty** | **Inv. Gaussian Frailty** |
| Reversal model[a] | | | | |
| *GDP per capita* | 0.345*** (0.061) | 0.093 (0.078) | 0.093 (0.078) | 0.093 (0.078) |
| *GDP growth* | 0.033** (0.014) | 0.045*** (0.015) | 0.045*** (0.015) | 0.045*** (0.015) |
| *Parliamentary* (vs. *Mixed*) | -0.018 (0.330) | -0.295 (0.310) | -0.295 (0.310) | -0.295 (0.310) |
| *Presidential* (vs. *Mixed*) | -0.010 (0.326) | 0.390 (0.290) | 0.389 (0.290) | 0.389 (0.289) |
| *Military* (vs. *Not independent*) | -0.880*** (0.325) | -0.287 (0.316) | -0.287 (0.316) | -0.287 (0.316) |
| *Civilian* (vs. *Not independent*) | -0.085 (0.332) | 0.136 (0.345) | 0.136 (0.344) | 0.136 (0.345) |
| *Monarchy* (vs. *Not independent*) | -0.100 (0.559) | 0.930* (0.533) | 0.930* (0.532) | 0.930* (0.532) |
| *Intercept* | 2.562*** (0.401) | 2.298*** (0.402) | 2.298*** (0.401) | 2.298*** (0.402) |
| *Shape parameter* $\alpha$ | 1.603*** (0.168) | 1.944*** (0.211) | 1.944*** (0.211) | 1.944*** (0.211) |
| *Frailty variance* $\theta^c$ | — | — | 0.000 (0.005) | 0.000 (0.008) |
| Consolidation model[b] | | | | |
| *GDP per capita* | — | 2.121*** (0.586) | 2.121*** (0.586) | 2.121*** (0.586) |
| *GDP growth* | — | -0.014 (0.227) | -0.014 (0.227) | -0.014 (0.227) |
| *Parliamentary* (vs. *Mixed*) | — | 2.231 (2.230) | 2.231 (2.230) | 2.231 (2.230) |
| *Presidential* (vs. *Mixed*) | — | -8.310** (3.958) | -8.310** (3.958) | -8.310** (3.958) |
| *Military* (vs. *Not independent*) | — | -4.061** (1.895) | -4.061** (1.895) | -4.062** (1.895) |
| *Civilian* (vs. *Not independent*) | — | -0.421 (1.097) | -0.421 (1.097) | -0.421 (1.097) |
| *Monarchy* (vs. *Not independent*) | — | -20.158 (2888.609) | -15.844 (891.870) | -13.965 (633.671) |
| *Intercept* | — | -6.144** (2.646) | -6.145** (2.647) | -6.144** (2.646) |

Note: Standard errors in parentheses. Significance levels *10%, **5%, ***1%.

[a]Model estimates the timing of reversals among transitional democracies via an exponential link function for the scale parameter $\lambda$.

[b]Model estimates $\pi$, the probability that a democracy is consolidated, via a logistic link function.

[c]Significance levels are based on the $\frac{1}{2}\chi^2_0 + \frac{1}{2}\chi^2_1$ likelihood ratio test statistic.