

Rulers' Age and the Stability of Governments: A Survival Analysis

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Abstract

In this study, we investigate the impact of the age of prime ministers and ministers on the stability of governments across 21 democracies. We examine this issue by using Cox survival analysis leveraging an original dataset and adopting a comparative perspective. The findings of the study document that younger prime ministers face a lower risk of government discretionary termination compared to their older counterparts. This effect does not appear to be statistically significant for cabinet ministers. By shedding light on this uncharted relationship, we contribute to the flourishing literature on youth representation in politics and the established research agenda on the factors affecting the survival in office of democratic governments. We conclude the study by discussing the implications of the findings for democracy and suggesting avenues for future research.

Keywords: Government Stability, Prime Ministers, Ministers, Age, Survival Analysis

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1 Appendix: supplementary materials intended for online publication

1.1 Appendix A

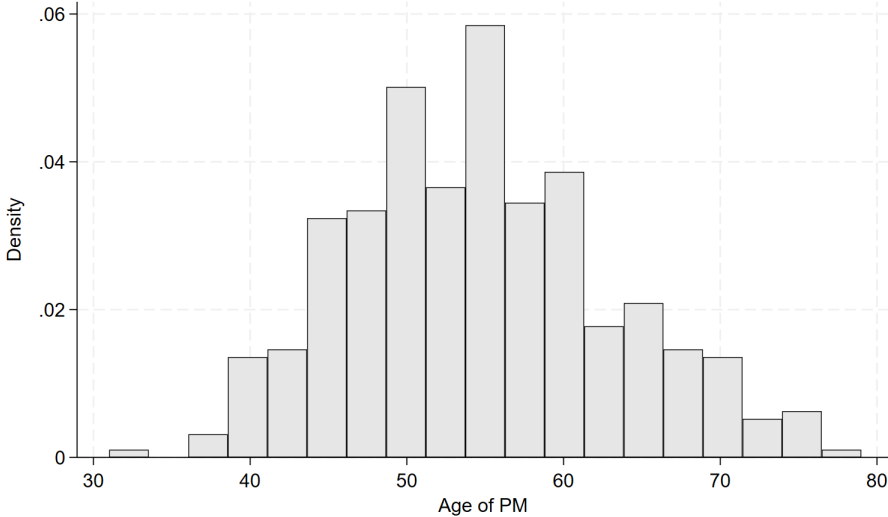


Figure 1: Histogram of Age of PM

The histogram shows the age distribution of Prime Ministers in our dataset. The distribution appears normal, centered around the age of 50, with most PMs falling in the 45–60 age range. There is a slight skew toward older ages, with fewer PMs under 40 or over 70. This suggests that most PMs are middle-aged, with a slight tendency towards older individuals within this category.

1.2 Appendix B

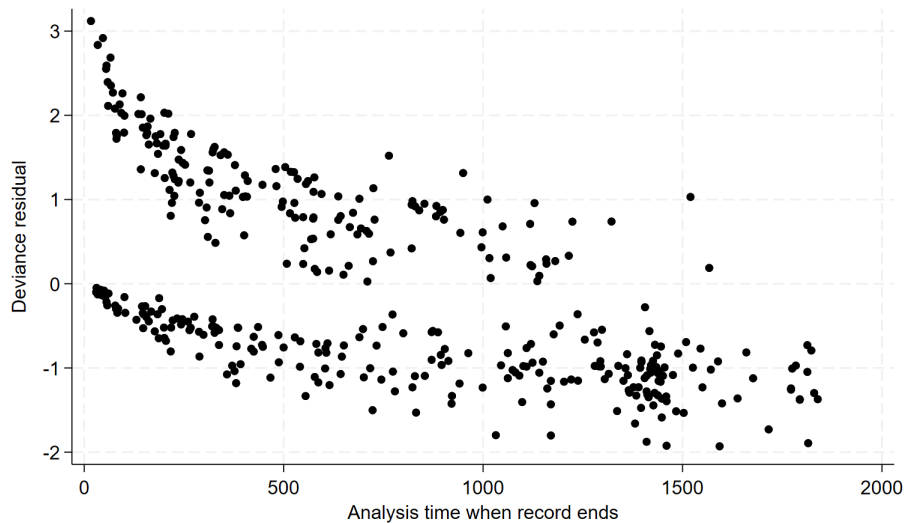


Figure 2: Deviance residual

In the context of Cox survival analysis, deviance residuals are used to assess the goodness of fit of the proportional hazards model. We thus performed deviance residuals as they help evaluate whether the Cox model adequately describes the relationship between covariates and survival time. Ideally, these residuals should be symmetrically distributed around zero, indicating no systematic bias in the model’s predictions. Large deviance residuals in Cox survival analysis can highlight observations where the model does not fit well, possibly due to unusual survival times or influential cases that deviate significantly from the expected pattern based on covariates. In our case, as regards the distribution, the residuals are approximately normally distributed around zero, with a slight tendency to decrease over time. As for the variance, the variance of the residuals appears to be relatively constant over time, suggesting that the variability of the data does not change significantly throughout the analysis. Finally, regarding the model, the general shape of

the graph indicates that the model used for the analysis may be adequate, as the residuals do not show systematic patterns or significant deviations from normality.

1.3 Appendix C

To test the goodness of the study’s analyses, we performed a log-rank test. In Cox survival analysis, this technique is often used to compare the survival distributions of different groups (e.g., groups based on age, treatment, or other categorical variables). In this context, the log-rank test helps to determine whether there are statistically significant differences between the survival curves of different groups. For instance, comparing survival times of governments led by young, middle-aged, and older leaders, the log-rank test evaluates if these groups have similar or significantly different survival times (i.e., the risk of termination). It is important to note that the log-rank test is non-parametric, meaning it does not assume a specific distribution for the survival times. This is useful because survival data often do not follow a normal distribution, and the test can still provide valid comparisons between groups without strict distributional assumptions. If survival curves for different groups cross frequently, this may indicate that the proportional hazards assumption could be violated, which is crucial in our study.

Table 1: Log-rank Test for Equality of Survivor Functions

Age Category	Observed Events	Expected Events
Young	13	19.81
Middle-aged	88	123.50
Older	209	166.70
Total	310	310.00

Chi-square (df = 2) 23.55
Pr chi2 0.0000

The output of the log-rank test provides information about the equality of survival curves among the age categories (Young, Middle-aged, and Older). The chi-square value is 23.55 with a p-value 0.0001, indicating that the test is highly significant. This result suggests that there are significant differences in the survival curves among the three age categories. This finding confirms that government duration varies significantly across the age groups of leaders. Indeed, young

leaders experienced 13 termination events compared to the expected 19.81, suggesting that governments led by younger leaders have a lower risk of termination than expected if survival curves were equal across all categories. Middle-aged leaders experienced 88 termination events versus the expected 123.50, also indicating a lower-than-average risk of termination. Older leaders had 209 termination events compared to the expected 166.70, suggesting a higher risk of termination compared to the other groups. In conclusion, the log-rank test confirms that leader age is associated with significant differences in government duration. Specifically, governments led by older leaders tend to terminate more quickly, while those led by young and middle-aged leaders show greater stability. This result supports the interpretation that leader age has a robust impact on government stability.

1.4 Appendix D

Table 2: Schoenfeld Proportional Hazards Test

Test	Chi-square	Degrees of Freedom	P-value
Global test	16.94	10	0.0758

The Schoenfeld Proportional Hazards Test is used to assess whether the proportional hazards assumption holds in a Cox proportional hazards model. The proportional hazards assumption is a key requirement for Cox regression, stating that the ratio of hazards (risk of the event occurring) between groups should remain constant over time. This assumption is crucial in our study because if it is violated, the results from a Cox model may be biased, as the model would incorrectly assume stable risk ratios over time.

In our study, the Schoenfeld test helps verify that the relationship between the independent variables (e.g., age category of the prime minister, government type, economic indicators) and the risk of government termination remains proportional over time. This assumption allows us to interpret the coefficients from our Cox model as consistent risk factors throughout the observation period. The output of the test provides a global chi-square statistic with an associated p-value. In our case, the p-value of 0.0758 is above the conventional significance level of 0.05, indicating that the global test is not significant. This result suggests that, overall, the proportional hazards assumption is met in our model. Therefore, we can reasonably conclude that the relationships between the variables and the risk of government termination do not vary significantly over time, supporting the validity of our Cox model in analyzing the factors influencing government stability.

1.5 Appendix E

As a further robustness test, we reran the Cox regression analyses by establishing a different age categorization, expanding and restricting both "young" and "old" thresholds.

The survival curve for rulers aged under 45 shows a higher survival probability relative to the other age groups, especially in the early stages of their tenure. This suggests that younger leaders tend to stay in office longer initially, compared to older leaders, even though the gap narrows as time progresses. Moreover, rulers in the 45-65 age group display a survival curve that is quite intermediate, with a higher probability of staying in office compared to the Over 65 category, but lower compared to the Under 45 category. Their survival probability drops more noticeably as time passes, signaling a greater likelihood of termination in office than younger leaders.

Most importantly, rulers aged over 65 have the lowest survival probability, particularly as their

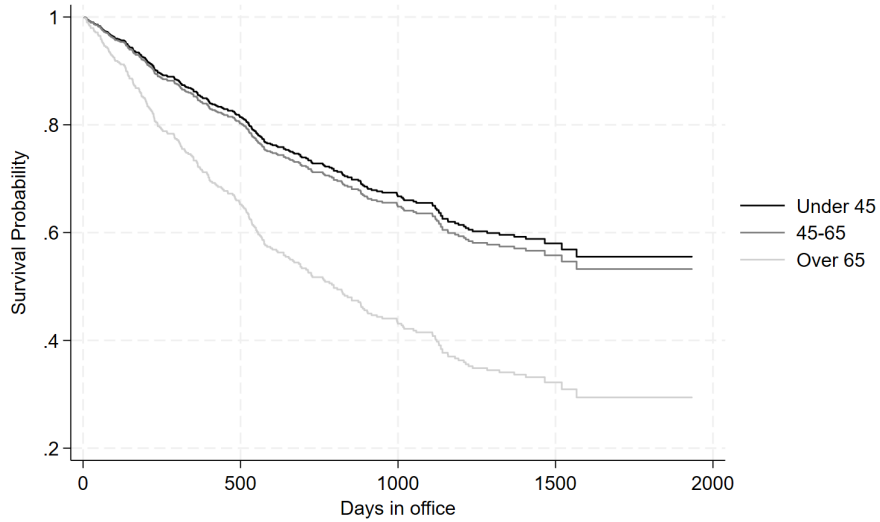


Figure 3: Cox survival curves (Alternative thresholds)

time in office increases. This category shows a significant decline in survival probability, confirming that older leaders face a higher risk of leaving office prematurely compared to younger ones.

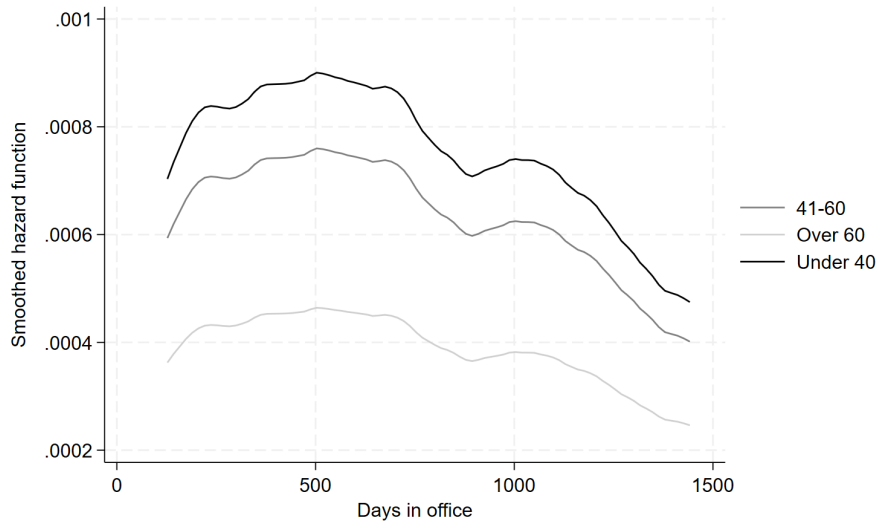


Figure 4: Cox survival curves (Alternative thresholds, smoothed functions)

From Figure 9, we can observe that rulers under 40 show the lowest hazard rate over time. This suggests that younger leaders experience the least risk of termination during their time in office. The curve stays consistently higher throughout the analysis period, indicating relative stability and less likelihood of leaving office. As for rulers aged 40-60, the curve shows an "intermediate" risk.

Finally, prime ministers aged over 60 show the highest hazard function throughout the analysis period, facing the highest risk of termination, especially over time. The steep decline in the curve signifies an elevated risk of leaving office for this group.

1.6 Appendix F

Variable	Obs	Mean	Std. Dev.	Min-Max
Government type	679	2.2489	1.1979	0 - 4
Number of effective parties	679	2.1816	1.0982	1 - 6.15
GDP rate	666	3.2140	3.3447	-16.91 - 19.56
Unemployment rate	525	6.0330	4.3188	0 - 24.5
Government debt	503	56.4199	35.1341	4.81 - 180.56
Bargaining duration	677	28.7799	61.0725	1 - 245
ENPP	670	3.9958	1.4269	1.96 - 9.7
Rile Weighted	610	-4.3687	16.4796	-61.4 - 63.08

Table 3: Descriptive Statistics for Control Variables

1.7 Appendix G

Variable	Hazard Ratio	Std. Error	z	P-value
Age Category				
Middle-aged	1.0315	0.3073	0.10	0.917
Older	1.8725	0.5408	2.17	0.030
Confidence Vote				
Constructive	0.4189	0.1216	-3.00	0.003
Investiture				
Positive	1.2839	0.1660	1.93	0.053
Electoral system				
District magnitude	0.9951	0.0514	-0.09	0.924

Table 4: Cox Regression Results with Institutional variables

A constructive vote of no confidence makes it harder to terminate a cabinet as the legislature needs to agree on an alternative prime minister to elicit the collapse of the prime minister (see e.g. ?). As regards the investiture vote, positive parliamentarianism requires the government to obtain the explicit support from the parliament (e.g. absolute majority of votes). In some national contexts, however, the government can rule without the support of the legislature (e.g.

minority situations in Scandinavia). In such contexts, there is a "negative parliamentarism" configuration (e.g. ?). Finally, to control for the effect of the electoral system, we used the district magnitude, where larger magnitudes indicate more "proportional-oriented" systems, as the likelihood of entering parliament for small parties is enhanced.

1.8 Appendix H

Table 5: Constitutional Interelection Period (CIEP) in 21 Democracies (Lower House)

Country	CIEP
Austria	5 years
Belgium	5 years
Cyprus	5 years
Denmark	4 years
Finland	4 years
France	5 years
Germany	4 years
Greece	4 years
Iceland	4 years
Ireland	5 years
Israel	4 years
Italy	5 years
Luxembourg	5 years
Malta	5 years
Netherlands	4 years
Norway	4 years
Portugal	4 years
Spain	4 years
Sweden	4 years
Switzerland	4 years
UK	5 years

Note: The constitutional interelection period (CIEP) is employed in comparative research for the study of coalition politics and government stability. It describes the maximum possible lifespan of a cabinet between elections (?).

1.9 Appendix I

Figure 10 displays the predicted log hazard of discretionary government termination as a function of the prime minister's age, based on a Cox proportional hazards model with age of pm included

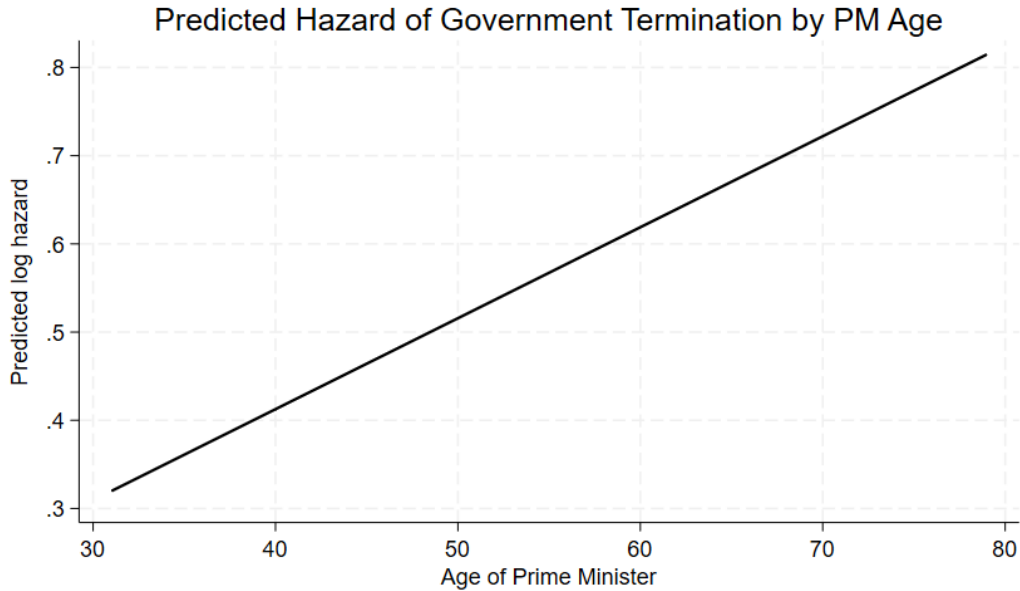


Figure 5: Predicted hazard of government termination by age of prime minister

as a continuous covariate. The curve reveals a clear linear relationship: as the prime minister’s age increases, the predicted hazard of government termination rises steadily. The slope of the curve suggests a modest but persistent increase in risk from age 30 to 80, with no evidence of non-linearities, threshold effects, or reversals. This result reinforces the main findings presented in the paper, showing that higher age is associated with greater instability. It also supports the choice of age categories used in the main models, by demonstrating that the observed effects are not artifacts of arbitrary cutoffs. Instead, the pattern appears to be driven by a substantive linear association between age and the risk of government collapse.

1.10 Appendix J

Table 11 reports the results of four Cox proportional hazards models using alternative age groupings for the prime minister’s age at the time of government formation. Model 1 (Under 45 / 45–59 / 60+) confirms that governments led by prime ministers aged 60 or above face a significantly higher risk of discretionary termination, with a hazard ratio of 1.95 (p-value 0.05), while the effect for the 45–59 group is not statistically significant.

Model 2 adopts a binary split (Under 50 vs. 50 and over) and similarly shows that governments

Table 6: Cox Proportional Hazards Models with Different Age Group Cut-offs

	Model 1	Model 2	Model 3	Model 4
45–59	1.089 (0.323)	–	–	–
60 and over	1.949* (0.560)	–	–	–
50 and over	–	1.795** (0.324)	–	–
55–64	–	–	1.332 (0.239)	–
65 and over	–	–	2.145*** (0.312)	–
50–69	–	–	–	1.316 (0.258)
70 and over	–	–	–	2.412*** (0.455)
N	679	679	679	679
LR χ^2	24.01	12.13	31.59	34.66
<i>p</i> -value	0.000	0.0005	0.000	0.000

Note: Hazard ratios reported. Standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

led by older prime ministers have significantly higher instability risks (HR = 1.80, *p*-value 0.01).

Model 3 (Under 55 / 55–64 / 65+) refines the categorization around later career stages. Here, the 65 and over group is associated with a sharply increased hazard (HR = 2.15, *p*-value 0.001), while the effect for the 55–64 group remains statistically non-significant.

Finally, Model 4 uses a more granular specification (Under 30 / 30–49 / 50–69 / 70+). Results again show that the highest age group (70 and over) is significantly associated with higher government instability (HR = 2.41, *p*-value 0.001), whereas other intermediate age bands do not show significant effects.

Overall, the consistency of findings across multiple specifications confirms the robustness of the main result: advanced age among prime ministers—particularly above 60 or 65—is linked to a heightened risk of early government termination. The results also suggest that the association becomes especially pronounced beyond certain age thresholds, supporting the theoretical claim that later career stages may alter incentives and governing capacity.

1.11 Appendix K

This figure displays the predicted duration of governments (in days) as a function of the mean age of the prime minister, based on a linear regression model. The downward-sloping line indicates a

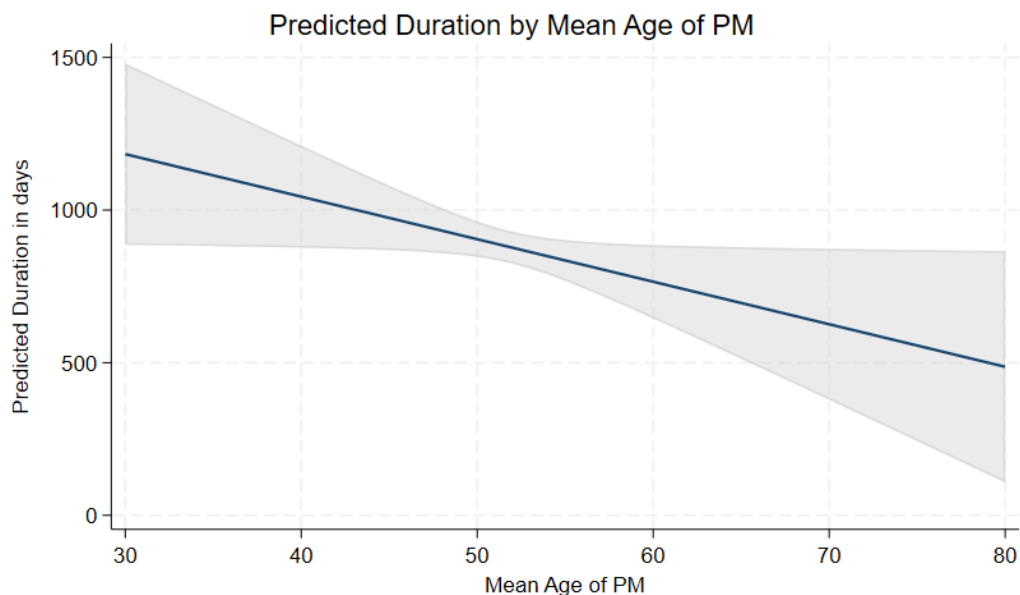


Figure 6: Predicted duration of governments by mean age of PM

negative relationship: as the average age of the PM increases, the expected duration of the government tends to decrease. The shaded area represents the 95 percent confidence interval, which widens at the extremes, suggesting greater uncertainty in predictions for very young or very old prime ministers. Overall, the plot supports the idea that higher average age is associated with shorter government lifespan.

1.12 Appendix L

We performed additional robustness test by examining the role of other economic indicators like inflation rates, measured as the annual percentage change in consumer prices and sourced from the World Bank’s Global Inflation Database (<https://www.worldbank.org/en/research/brief/inflation-database>). Inflation exhibits a statistically significant and positive association with the hazard of government termination. Specifically, the hazard ratio of 1.015 (p 0.05) suggests that each additional percentage point increase in inflation raises the risk of early government collapse by approximately 1.5 percent. This finding indicates that macroeconomic instability—in the form of rising consumer prices—may undermine stability and reduce government longevity. It should be noted that in this model, we opted not to include GDP growth as an additional

Table 7: Cox Regression with Inflation and Other Controls

Variable	Hazard Ratio	Std. Err.	p-value
Middle-aged	1.014	0.322	0.965
Older	1.969*	0.624	0.033
Multiparty minority	1.081	0.331	0.800
Singleparty minority	1.156	0.354	0.635
Oversized coalition	1.479	0.320	0.071
Singleparty majority	0.375*	0.148	0.013
Effective Number of Parties	1.219	0.146	0.099
Unemployment Rate	0.979	0.026	0.431
Government Debt	1.004	0.003	0.232
Inflation	1.015*	0.020	0.014
Bargaining Duration	0.993*	0.002	0.009
ENPP	1.003	0.081	0.969
RILE Weighted	0.993	0.005	0.196
N		376	
Failures		149	
Time at Risk		282,339	
LR χ^2 (13)		52.66	
Log Likelihood		-771.93	
Prob χ^2		0.0000	

Note: * $p < 0.05$; Focal variable's reference category: Younger PM; Ref. category Government Type: Minimal winning coalition. Age categories: Under 45, 45-60, Over 60

covariate as including both variables simultaneously could introduce multicollinearity and obscure the individual effect of inflation, as the GDP can be influenced by inflation rates (e.g. ?; ?).

1.13 Appendix M

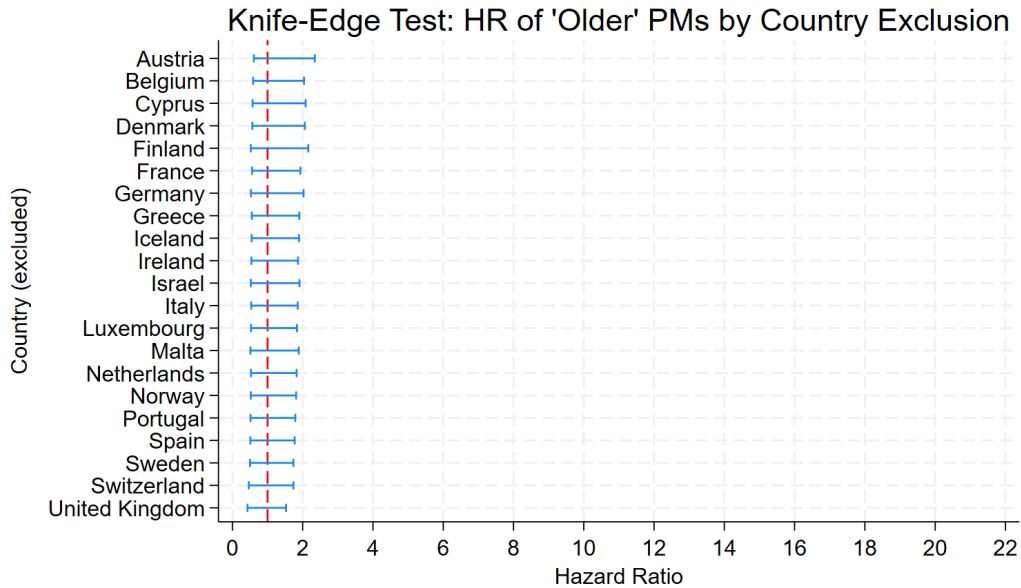


Figure 7: Knife-edge test

We performed an additional robustness test to assess whether our main finding—the heightened instability risk associated with older prime ministers—was driven by any individual country in the dataset. To do so, we conducted a leave-one-out (LOO) analysis with Stata19, commonly referred to as a knife-edge test, in which we re-estimated the Cox proportional hazards model 21 times, each time excluding one country from the sample. For each iteration, we extracted the hazard ratio (HR) and the 95 percent confidence interval (CI) for the "Older" age category (i.e., prime ministers aged 60 or above). Figure 12 summarizes the results of this procedure, displaying the HRs along with their corresponding CIs for each exclusion.

As shown in the figure, the point estimates of the hazard ratio remain remarkably stable across all country exclusions. While the width of the confidence intervals varies—as expected due to reduced sample size in each iteration—all intervals overlap substantially with the confidence interval of the full model, and none of the country exclusions results in a statistically significant reversal

or attenuation of the effect. This pattern provides compelling evidence that our core finding is not driven by any single country, and instead reflects a robust and generalizable association between ruler age and government stability across the 21 established democracies in our sample.

1.14 Appendix N

Table 8: Cox Regression with Shared Frailty (Gamma) by Country

Variable	Hazard Ratio	Std. Err.	p-value
<i>Age Category</i>			
Middle-aged	0.948	0.309	0.869
Older	2.032*	0.668	0.031
<i>Type of Government</i>			
Multiparty minority	1.396	0.540	0.389
Singleparty minority	1.251	0.458	0.541
Oversized coalition	0.871	0.211	0.568
Singleparty majority	0.231**	0.111	0.002
Effective Number of Parties	1.080	0.138	0.548
GDP growth rate	0.993	0.032	0.835
Unemployment rate	0.927*	0.034	0.036
Government debt	0.998	0.004	0.652
Bargaining duration	0.997	0.002	0.147
ENPP	1.016	0.113	0.888
RILE weighted	1.002	0.005	0.674
Theta (frailty variance)	0.918	0.357	
LR test of $\theta = 0$	$\chi^2(1) = 48.68, p = 0.000$		
N	407		
Failures	169		
Groups (Countries)	21		
Log Likelihood	-868.97		
Wald $\chi^2(13)$	42.65, $p = 0.0001$		

Note: * $p < 0.05$, ** $p < 0.01$. The frailty model accounts for unobserved heterogeneity across countries.

To further assess the robustness of our core finding regarding the destabilizing effect of rulers' age, we estimate a Cox proportional hazards model including a shared frailty term at the country level. This specification accounts for unobserved heterogeneity across countries by introducing a gamma-distributed random effect for each group. The frailty model is particularly useful to verify whether our main results are driven by systematic differences or outliers at the country level.

As shown in the table, the hazard ratio for the “Older” category remains positive and statistically significant (HR = 2.03, $p = 0.031$), consistent with our main models. The estimated variance of the frailty term ($\theta = 0.918$) is significant, as confirmed by the likelihood-ratio test ($\chi^2 = 48.68$, $p < 0.001$), which validates the presence of unobserved country-level heterogeneity.

Overall, this analysis reinforces the substantive conclusion that advanced age increases the risk of government termination and demonstrates that the observed association is not an artifact of outlier countries or unmodeled group-level variance.

1.15 Appendix O

Table 9: Cox Regression Results Excluding Potential Outliers

Variable	Excl. France	Excl. Finland	Excl. Italy
Middle-aged (ref: U45)	0.809 (0.262)	1.063 (0.384)	1.041 (0.329)
Older (60+)	1.857* (0.586)	2.085* (0.743)	2.193* (0.688)
Multiparty minority	1.202 (0.369)	1.035 (0.322)	0.890 (0.270)
Singleparty minority	1.808 (0.567)	1.253 (0.365)	1.215 (0.356)
Oversized coalition	1.521 (0.340)	1.593* (0.333)	1.569* (0.315)
Singleparty majority	0.675 (0.262)	0.348* (0.142)	0.477* (0.177)
Effective Number of Parties	1.427* (0.201)	1.184 (0.139)	1.214 (0.142)
GDP Growth Rate	1.011 (0.032)	1.020 (0.034)	1.007 (0.030)
Unemployment Rate	0.964 (0.027)	0.975 (0.027)	0.984 (0.025)
Government Debt	1.002 (0.004)	1.005 (0.004)	1.002 (0.003)
Bargaining Duration	0.996 (0.002)	0.995* (0.002)	0.995* (0.002)
ENPP	0.942 (0.079)	0.898 (0.071)	1.006 (0.078)
RILE Weighted	0.997 (0.005)	0.997 (0.005)	0.997 (0.005)
Observations	376	370	373
Failures	147	147	144
Time at Risk	283,467	278,338	240,064
LR χ^2 (13)	48.95	46.20	53.81
Log Likelihood	-767.20	-765.58	-886.36
Prob χ^2	0.000	0.000	0.000

Note: Hazard ratios reported. Standard errors in parentheses. * $p < 0.05$. Focal age reference category: Prime ministers under 45. Reference category for government type: Minimal winning coalition.

We conducted additional robustness checks to assess whether our main findings could be driven by any specific country in the sample. In particular, we re-estimated the Cox proportional hazards model three times, each time excluding one country (France, Finland, and Italy). As reported in

Table 14, the hazard ratio for the “Older” category (prime ministers aged 60 or over) remains statistically significant and substantively similar across all three specifications. This confirms that the positive association between advanced age and government instability is not driven by any single country, thereby strengthening the robustness of our results.

1.16 Appendix P

Table 10: Descriptive Statistics – Ministers in High-Prestige Portfolios by Age Group

Age group	N	Mean	Std. Dev.	Min	Max
Under 45	1,527	8.91	16.21	0	100
45-60	1,527	67.69	26.09	0	100
Over 60	1,527	23.13	26.04	0	100

Table 15 presents descriptive statistics on the age distribution of ministers holding high-prestige portfolios. The data reveal that ministers aged 45 to 60 are by far the most represented group, holding on average nearly 68 percent of such positions. By contrast, younger ministers (under 45) occupy only 9 percent of high-prestige roles on average, while older ministers (over 60) account for approximately 23 percent. These patterns support the idea that younger ministers appear systematically underrepresented in the most influential cabinet positions. We conducted these analyses using the WARC dataset(?).

1.17 Appendix Q

Table 11: Typology of Ministerial Portfolios by Prestige Level

High Prestige	Medium Prestige	Low Prestige
Finance	Agriculture	Children and Family
Foreign Affairs	Construction and Public Works	Culture
Government	Education	Science and Technology
Public Security	Environment and Natural Resources	Sports
Economy	Health and Social Welfare	Tourism
Interior	Industry and Commerce	Women's Affairs
Defense	Justice	Ministers for reform of the state
State	Labor	Transient ministries
Home Office / Civil Affairs	Communications and Information	Ministers without portfolio
Treasury	Transportation	
Vice Executive		

Table 16 presents the typology of ministerial portfolios by prestige level, as indicated by Stockemer and Sundström (?: 448).

1.18 Appendix R

We conducted additional robustness tests to verify the (lack of) impact of young cabinet ministers on government termination. We specifically employ a different operationalization by focusing on the share of different age groups in cabinet.

Table 12: Cox Regression Analysis of Ministers' Age Groups on Termination

	Model 1 (Under 45)	Model 2 (45 to 60)	Model 3 (60 plus)
Haz. ratio	1.0044	0.9886	1.0099
Std. Err.	0.0075	0.0056	0.0058
No. of subjects		379	
No. of failures		145	
Time at risk		332,845	
Log likelihood	-786.9131	-785.0929	-785.6795
LR chi2 (df = 1)	0.34	3.98	2.80
Prob chi2	0.5625	0.0462	0.0941
AIC	1575.826	1572.186	1573.359
BIC	1579.764	1576.123	1577.297

Overall, the analyses reveals that a higher share of middle-aged ministers (45–60) is associated with greater government stability (Model 2). By contrast, a higher proportion of older ministers appears linked to reduced stability (Model 3), while the presence of younger ministers shows no clear association. However, such relationships are statistically weak, as demonstrated by the Cox survival curves.

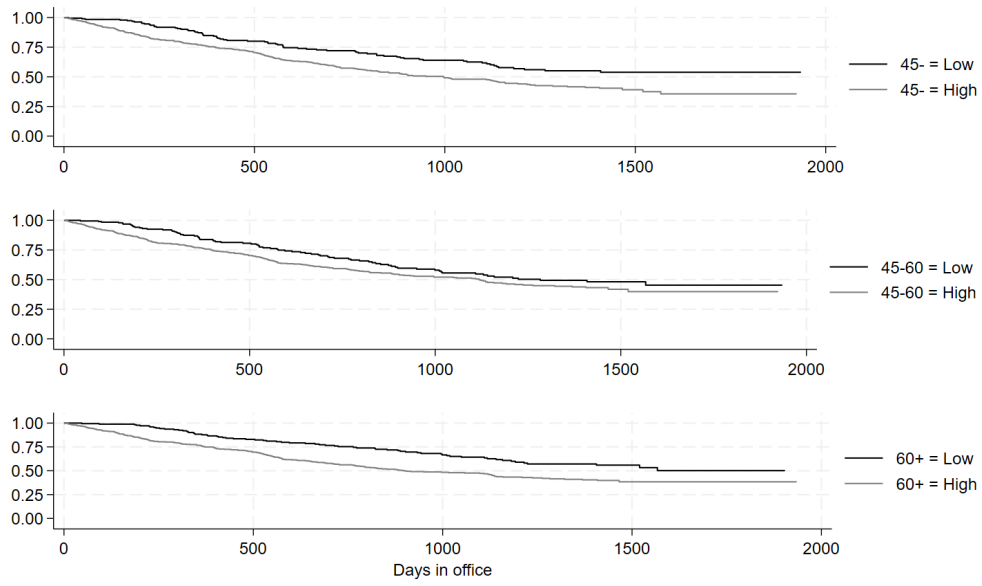


Figure 8: Cox survival curves of ministers

1.19 Appendix S

Table 13: Cox Regression with Mean Age of Ministers

Variable	Hazard Ratio	Std. Error	95% CI
<i>Mean Age of Ministers</i>	1.035	0.027	[0.984, 1.089]
<i>Type of Government</i>			
Multiparty minority	0.883	0.345	[0.411, 1.898]
Singleparty minority	1.128	0.375	[0.587, 2.165]
Oversized coalition	1.435	0.328	[0.917, 2.246]
Singleparty majority	0.316**	0.132	[0.140, 0.715]
Effective Number of Parties	1.144	0.129	[0.917, 1.427]
GDP growth rate	1.001	0.032	[0.939, 1.066]
Unemployment rate	1.001	0.029	[0.945, 1.060]
Government debt	1.004	0.004	[0.997, 1.011]
Bargaining duration	0.994*	0.003	[0.989, 0.999]
ENPP	0.997	0.088	[0.838, 1.186]

N = 315; *Failures* = 127; *Time at risk* = 271,775

Log Likelihood = -645.93; *LR* $\chi^2(11)$ = 40.09; *p* 0.001

Note: * *p* < 0.05, ** *p* < 0.01

Table 18 presents the Cox regression table on which the Cox survival curves about the impact of young cabinet ministers are based

1.20 Appendix T

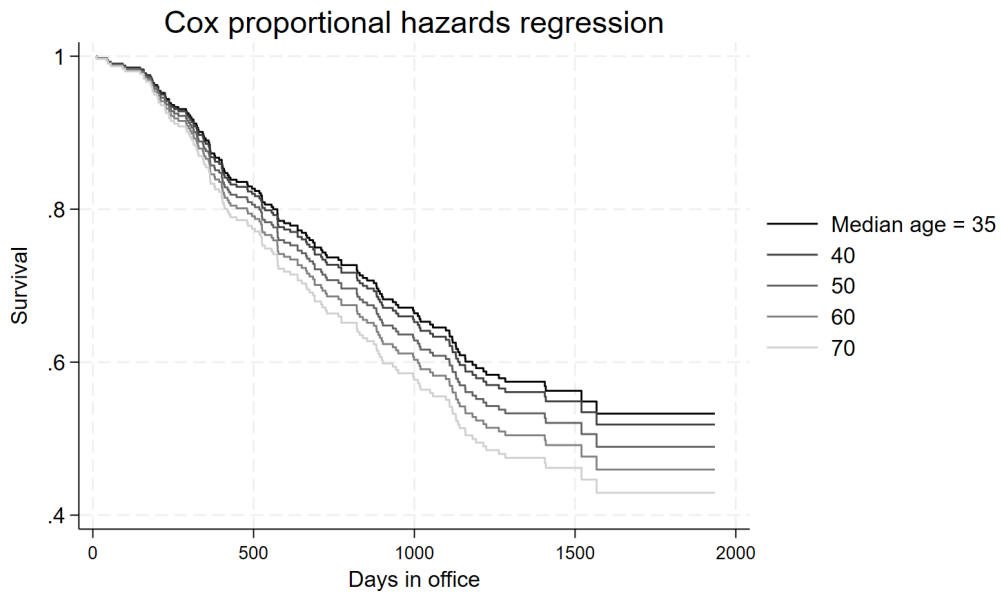


Figure 9: Cox survival curves of ministers (median age)