The Correlates of Nuclear Proliferation

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Introduction

Concerns about nuclear proliferation has grown

- Withdrawal of superpower security after the Cold War
- Technological progress for many countries to develop atomic weapon
- Possibility of nuclear power passed into terrorist organization

→ What causes nuclear proliferation?

How to do research①

- Quantitative test(+Qualitative and Comparative study)

→quantitative analyses that include observations covering the full range of variance on both the dependent and independent variables can provide a useful complement to qualitative approaches

Defining four stages (Multilevel Indicator≒Dependent Variable)

1. No noticeable interest in nuclear weapon
2. Serious exploration of the weapons option
3. Launch of a weapons program
4. Acquisition of nuclear weapons

How to do research②

3 broad approaches to nuclear proliferation to test hypotheses(Independent Variable)

1. Technological determinants
2. External determinants
3. Internal determinants

Dependent Variable

The measurement for multilevel indicator is dependent variable

1. First explosion/assembly of weapons (acquisition)
2. Pursuit of weapons

Political decision by cabinet-level officials, movement toward weaponization, or development of single-use, dedicated technology in order to aim at acquiring nuclear weapon.

3. Exploration of weapons

Technological Determinants

3 measurements to know the latent capacity to develop nuclear weapon

1. Economic prosperity
2. Literacy levels
3. Scientific development

This lack of empirical support, but it is important because every country has to have minimal economic/technological capacity. Necessary but insufficient condition.

How to measure Technological Determinants

1. Gross domestic product per capita

This reflects level of economic development which is linked to sophisticated technical, engineering, and manufacturing knowledge necessary for the development and nuclear arms.

2. Industrial capacity index
3. Energy, electricity, and steel production and consumption

External Determinants

Focus on 2 factors

1. Presence (or absence) of a security threat
2. Security guarantee from a powerful alliance partner

Many realists emphasize the threat environment for pursing nuclear arms, but there are selection bias in their research and countries have at least three potential choice for security threat. Also under multipolarity, security guarantees are withdrawn or less credible.

How to measure External Determinants

1. Enduring rivalry

Dichotomous variable indicating whether a state was involved in one or more enduring rivalries in a given

2. Frequency of dispute involvement

Calculate the 5-year moving average of the number of militarized interstates per year

3. Security guarantee

United States, Soviet Union/Russia, United Kingdom, France, and China is counted as nuclear-capable, great power allies

Count defense pacts as providing a significant security guarantee

Domestic Determinants

Focus on 4 factors

1. Democracy

"Core" states constitutes liberal democracies with shared norms and values which foster international cooperation with "periphery" states; there is exception

2. Liberalizing governments

Economic component of domestic liberalization in reducing the appeal of nuclear weapons.

3. Autonomous domestic elite

Degree of autonomy afforded the domestic elite in choosing to pursue nuclear arms

4. Symbolic/status motivation

State's behavior is determined by shard beliefs and norms in international relations

How to measure Domestic Determinants

1. Democracy and democratization

Measurement of the level of democracy within each state by combining the two separate 11-point scales for democracy and autocracy from Polity IV:

$dem_i = democ_i - auto_i$

2. Economic interdependence and liberalization

- exports plus imports as a share of GDP as a measure of exposure to the international eoconomy
- calculating the change in trade ratios over spans of 3, 5, and 10 years to measure of trade liberalization.

3. Status inconsistency/symbolic motivations

Compare each country with the United States and with each state's leading regional power

Methods

Event history model and multinomial logistic regression

- Method that is both well suited to rare events and able to model the effects of time ; that accounts for “right censoring” and avoids the selection bias ; that allows to include explanatory variables that change in value over the observation period

This model provide estimates of the probability of a state going nuclear or starting down that path at a particular time

$$h(t|x_j) = pt^{p-1}\exp(\beta_0 + x_j B_x),$$

Result

TABLE 2
The Correlates of Nuclear Weapons Proliferation

Independent Variable	*Dependent Variable*		
	Explore	*Pursue*	*Acquire*
Technological determinants			
GDP per capita	0.00052 [.119]	**0.001** [.017]	0.0002 [.378]
	(0.0003)	(0.0004)	(0.0003)
GDP squared	**–3.66e-08** [.094]	**–7.92e-08** [.017]	**–2.36-08** [.100]
	(2.19e-08)	(3.11e-08)	(1.43e-08)
Industrial capacity index	**1.89** [.016]	**1.46** [.046]	**3.19** [< .001]
	(0.78)	(0.73)	(0.91)
External determinants			
Enduring rivalry	**1.57** [.002]	**1.83** [.024]	**2.13** [.076]
	(0.50)	(0.81)	(1.77)
Dispute involvement	**0.17** [.010]	**0.38** [< .001]	**0.23** [.070]
	(0.07)	(0.09)	(0.13)
Alliance	–0.67 [.260]	–0.83 [.194]	–1.01 [.225]
	(0.59)	(0.64)	(0.83)
Internal determinants			
Democracy	0.02 [.525]	**0.070** [.084]	0.092 [.123]
	(0.038)	(0.038)	(0.059)
Democratization	–0.03 [.578]	–0.080 [.323]	0.016 [.895]
	(0.056)	(0.081)	(0.120)
Percentage of democracies	–0.05 [.204]	**–0.186** [.007]	–0.094 [.351]
	(0.04)	(0.069)	(0.101)
Economic openness	–0.01 [.235]	–0.018 [.112]	0.0002 [.989]
	(0.01)	(0.012)	(0.015)
Economic liberalization	**–0.037** [.030]	**0.35** [.010]	–0.001 [.963]
	(0.017)	(0.014)	(0.018)
Constant	**–4.66** [< .001]	**–6.34** [.016]	–7.52 [.022]
	(1.32)	(2.63)	(3.29)
Ancillary parameter (p)	0.55	1.42	1.04
Standard error (p)	0.113	0.48	0.36
Log likelihood	–56.12	–28.57	–19.61
Number of countries	149	149	149
Total observations	5,215	5,578	5,784

NOTE: Coefficients are estimates for parametric survival models with a Weibull distribution; robust standard errors, adjusted for clustering by country, are in parentheses. p values are superscripted and are for two-sided tests. Coefficients that are significant at better than the 10% level are bold. GDP = gross domestic product.

TABLE 3

Substantive Effects of the Explanatory Variables on the Likelihood of Exploring Nuclear Weapons

Variable	*Percentage Change from Baseline Hazard Rate*	
	Explore	*Acquire*
Great-power military alliance	–49	–64
Participation in ongoing enduring rivalry	+382	+743
Increase in frequency of MIDs (two more/year)	+38	+52
Industrial capacity threshold	+563	+2,340
Increase in trade openness	–72	–2
Increase in per capita GDP—$500 at very low level	+26	+12
Increase in per capita GDP—$500 at high level	–20	–17
Satisfaction	+40	–82
Increase in democracy	+25	+94

NOTE: MID = militarized interstate dispute; GDP = gross domestic product.

TABLE 4

Pathways to Proliferation: Multinomial Logit Models

Independent Variable	*Level*		
	1 (Explore)	*2 (Pursue)*	*3 (Acquire)*
Technological determinism			
GDP per capita	**0.0003**$^{<.001}$	**0.0005**$^{<.001}$	**0.0004**$^{<.001}$
	(0.00005)	(0.0001)	(0.0001)
GDP squared	**–1.55e-08**$^{<.001}$	**–4.36e-08**$^{<.001}$	**–1.00e-08**$^{<.001}$
	(2.73e-09)	(7.86e-09)	(1.80e-09)
Industrial capacity index	**2.88**$^{<.001}$	**2.41**$^{<.001}$	**22.59**$^{<.001}$
	(0.270)	(0.280)	(0.664)
External determinants			
Enduring rivalry	**0.43**$^{.017}$	**0.67**$^{.003}$	**1.61**$^{<.001}$
	(0.179)	(0.221)	(0.240)
Dispute involvement	**0.31**$^{.002}$	**0.77**$^{<.001}$	**0.86**$^{<.001}$
	(0.099)	(0.105)	(0.119)
Alliance	**–1.24**$^{<.001}$	–0.22$^{.205}$	**–1.25**$^{<.001}$
	(0.19)	(0.18)	(0.18)
Internal determinants			
Democracy	**0.020**$^{.073}$	**–0.027**$^{.055}$	**0.029**$^{.018}$
	(0.011)	(0.014)	(0.012)
Democratization	–0.005$^{.790}$	0.003$^{.937}$	–0.023$^{.334}$
	(0.020)	(0.032)	(0.024)
Percentage of democracies	**–0.122**$^{<.001}$	0.017$^{.390}$	**0.036**$^{.066}$
	(0.017)	(0.019)	(0.019)
Economic openness	**–0.028**$^{<.001}$	**–0.012**$^{.001}$	**–0.027**$^{<.001}$
	(0.003)	(0.003)	(0.003)
Economic liberalization	0.002$^{.917}$	–0.007$^{.299}$	0.003$^{.675}$
	(0.009)	(0.007)	(0.007)
Constant	**–1.47**$^{.006}$	**–6.95**$^{<.001}$	**–28.31**$^{<.001}$
	(0.538)	(0.745)	(0.339)

NOTE: Log pseudo-likelihood = –1874; pseudo-R^2 = 0.39; total observations = 6,125. The reference category is no steps to pursue nuclear weapons. Coefficients are estimates for multinomial logit regression models, with robust standard errors in parentheses. p values are superscripted and are for two-sided tests. Coefficients that are significant at better than the 10% level are in bold. GDP = gross domestic product.

Puzzling Misses

TABLE 5
Dogs That Didn't Bark? Countries That Did Not Seriously Explore the Nuclear Option . . . but Should Have

Country	*Years of Maximum Predicted Hazard*
Saudi Arabia	Mid-1980s to mid-1990s
West Germany	Mid-1950s to early 1960s
Japan	Mid-1950s to 1960s
Turkey	Late 1960s to 2000
Bulgaria	1950s
Spain	1960s to early 1970s
Greece	1960s and 1980s
Italy	1950s to early 1960s
Syria	Various

Conclusion

- According to the new data set on nuclear weapons proliferation, nuclear weapons proliferation is reasonably well accounted for by the level of economic development and the external threat environment
- Therefore, by reducing the threat posed by its external environment , accelerating economic growth, encouraging integration into the world economy and encouraging a defensive alliance with a great power will reduce country's temptation to pursue nuclear arms.