# DETERMINANTS OF NUCLEAR WEAPONS PROLIFERATION

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# RESEARCH DESIGN

- Seek to estimate the effect of measures of opportunity and willingness on nuclear weapons programs and nuclear weapons possession

Three potential outcomes:

(1) States that lack both nuclear weapons programs and nuclear weapons

(2) States with nuclear weapons programs that have yet acquired nuclear weapons

(3) States that possess both a nuclear weapons program and nuclear weapons.1

# OPPORTUNITY

- Possibilities that are available to any entity within any environment, representing the total set of environmental constraints and possibilities
- Set of technologies (knowledge) related to the manufacture of nuclear weapons.
- Nuclear fissile materials
- Economic capacity

# WILLINGNESS

- Set of factors leading to the eagerness of a country to possess nuclear weapons
- Domestic and geopolitical conditions that influence the decision to seek nuclear weapons
- Only states that are willing to suffer significant international disapproval and are materially capable of proliferation are likely to proliferate

- International Security
  - deter potential adversaries from initiating conflicts
- Domestic Security
  - divert public attention from unfavorable domestic issues
  - regime type
- Norms
- Status
  - Develop nuclear weapons to represent or enhance their perceived prestige

# CONTROL VARIABLES

- Nonnuclear Years counts the number of years since 1939 that lapse without a state starting a nuclear production program
- Nuclear Program Years is a count of the number of years since a state passed the first stage of nuclear proliferation

# DEPENDENT VARIABLES

- NWEAPON - identifies whether a state possesses nuclear weapons in a given year, provided that the state has an active nuclear weapons program
- NPROGRAM- codes whether a state has an active nuclear weapons development program in a given year

# INDEPENDENT VARIABLES- OPPORTUNITY

- Latent nuclear weapons production capability- uranium deposits, metallur gists, chemical engineers, and nuclear engineers/physicists/chemists, electronic/explosive specialists, nitric acid production capacity, and electricity production capacity- a codebook (variable varies between zero and seven (seven being highest)

- Economic capacity $$\text{Economic capacity} = \left( Energy_i \Big/ \sum Energy + Iron/Steel_i \Big/ \sum Iron/Steel \right) \Big/ 2$$

- Diffusion- log transformation of the number of years since 1938

# INDEPENDENT VARIABLES- WILLINGNESS

International Security:

- Conventional threat $$\text{Conventional threat}_{i,t} = \ln\left(\sum_{j=1}^{n} \frac{CINC_{j,t}}{CINC_{i,t}} + 1\right)$$
- Nuclear threat- coded 1 for states that have at least one rival with a nuclear weapons program or actual nuclear weapons and 0 otherwise
- Nuclear defense pact- coded the variable as a dummy that equals 1 if a state has a defense pact with a declared nuclear power and 0 otherwise
- Diplomatic isolation- coded the ratio of the number of states with which a given state lacks diplomatic relationships to the number of neighboring states and major powers

# INDEPENDENT VARIABLES- WILLINGNESS CONT.

Domestic Politics:

- Domestic unrest- weight the number of reported domestic conflicts in three categories including antigovernmental demonstrations, strikes, and riots by the size of the state's population
- Democracy- Polity Project's democracy score (DEMOC)

Status:

- NPT membership- dummy variable is coded 1 for states that ratified the NPT and 0 otherwise
- NPT (system effect)- measured as the proportion of NPT joiners to the total number of states in the world.

# INDEPENDENT VARIABLES- WILLINGNESS CONT.

Status:

- Major power status- adopt the standard COW classification
  - Major powers in the period under study include the United States (1939-1992), United Kingdom (1939-1992), Soviet Union/Russia (1939-1992), France (1939-1940 and 1945 1992), Germany (1939-1945, 1991-1992), Italy (1939-1943), Japan (1939-1945, 1991-1992), and China (1950-1992).
- Regional power status- identify all states with at least half of the resources of the most powerful state in each region using the COW project's code of region and CINC and code the list of states that result but that are not major powers as regional powers.
  - Regional powers include China (1939 1949), Egypt (1939-1946, 1949-1992), Ethiopia (1941-1945, 1984, 1987-1990), India (1986-1992), Iran (1939-1945, 1951-1980, 1982-1992), Iraq (1981-1990, 1992), Japan (1986-1990), Nigeria (1960-1992), Saudi Arabia (1979-1987, 1990 1992), South Africa (1939-1991), and Turkey (1939-1992).

## Statistical Analyses of Nuclear Proliferation

| Dependent Variable<br>Nuclear Weapons Possession Status | Model 2-1: Censored Model<br>Coeff. | S.E. | Sig. | Model 2-2: Noncensored Model<br>Coeff. | S.E. | Sig. |
|---|---|---|---|---|---|---|
| Independent variables | | | | | | |
| Latent nuclear weapons production capability$_{i,t-1}$ | 0.4275 | (0.448) | | 0.6082 | (0.233) | *** |
| Economic capacity$_{i,t-1}$ | 110.5096 | (28.70) | **** | 6.5480 | (3.929) | * |
| Diffusion$_{t-1}$ | 13.0360 | (3.801) | *** | 1.9503 | (0.698) | *** |
| Conventional threat$_{i,t-1}$ | 2.7294 | (0.453) | **** | 1.3437 | (0.258) | **** |
| Nuclear threat$_{i,t-1}$ | –5.0045 | (0.834) | **** | –2.1532 | (0.604) | **** |
| Nuclear defender$_{i,t-1}$ | –3.5502 | (0.902) | **** | –1.3794 | (0.576) | ** |
| Diplomatic isolation$_{i,t-1}$ | 0.3904 | (1.068) | | 1.6953 | (0.867) | * |
| Domestic unrest$_{i,t-1}$ | 0.1632 | (0.129) | | 0.4322 | (0.120) | **** |
| Democracy$_{i,t-1}$ | 0.2709 | (0.107) | *** | 0.0666 | (0.059) | |
| NPT(system effect)$_{t-1}$ | –0.0169 | (0.035) | | 0.0007 | (0.006) | |
| Major power status$_{i,t-1}$ | 7.4898 | (1.040) | **** | 4.6929 | (0.741) | **** |
| Regional power status$_{i,t-1}$ | 1.2096 | (0.498) | ** | 1.5459 | (0.495) | *** |
| Count2 | –0.1474 | (0.029) | **** | –0.0652 | (0.034) | * |
| Constant | –53.8317 | (10.13) | **** | –14.8721 | (2.477) | **** |
| Obs. | | 440 | | | 4,697 | |
| Log likelihood | | –26.09 | | | –133.16 | |
| Pseudo $R^2$ | | 0.914 | | | 0.861 | |
| Wald chi-square | | 606.935 | **** | | 201.6 | **** |

**Table 1 (continued)**

| Dependent Variable<br>Nuclear Weapons Program Status | Coeff. | Model 1<br>S.E. | Sig. |
|---|---|---|---|
| Independent variables | | | |
| Latent nuclear weapons production capability$_{i,t-}$ | 0.4836 | (0.079) | **** |
| Economic capacity$_{i,t-1}$ | 1.4826 | (1.944) | |
| Diffusion$_{t-1}$ | 1.0550 | (0.251) | **** |
| Conventional threat$_{i,t-1}$ | 0.7002 | (0.258) | *** |
| Nuclear threat$_{i,t-1}$ | –0.9140 | (0.364) | ** |
| Nuclear defender$_{i,t-1}$ | –0.0976 | (0.306) | |
| Diplomatic isolation$_{i,t-1}$ | –0.0602 | (0.438) | |
| Domestic unrest$_{i,t-1}$ | –0.1480 | (0.096) | |
| Democracy$_{i,t-1}$ | –0.0262 | (0.022) | |
| NPT membership$_{i,t-1}$ | –0.7809 | (0.363) | ** |
| NPT(system effect)$_{t-1}$ | 0.0052 | (0.004) | |
| Major power status$_{i,t-1}$ | 2.0000 | (0.388) | **** |
| Regional power status$_{i,t-1}$ | 1.5491 | (0.236) | **** |
| Count1 | –0.1132 | (0.012) | **** |
| Constant | –6.3543 | (1.001) | **** |
| Obs. | | 4,697 | |
| Log likelihood | | –256.71 | |
| Pseudo $R^2$ | | 0.824 | |
| Wald chi-square | | 644.5 | **** |

Notes: Statistically significant parameter estimators are denoted by * ($p < .10$), ** ($p < .05$), *** ($p < .01$), and **** ($p < .001$).
The sample in Model 2-1 includes country-years where a given country has an active nuclear weapons program.

# DOMESTIC POLITICS RESULTS

- Democracy has a significant and positive coefficient in the nuclear weapons possession stage only. This finding implies that democratic states are more likely to produce nuclear weapons provided that they have already begun a nuclear development program, while there is no difference in initiating nuclear weapons programs between autocracies and democracies. These results support populist arguments that democracies are more vulnerable to nationalist pressure
- Domestic Unrest does not affect proliferation at either stage. It appears that support for diversion arguments is very weak or nonexistent

# NORMS VARIABLE RESULTS

- NPT Membership decreases the likelihood of having nuclear weapons programs. These results do not necessarily imply that the NPT changes state preferences, however. States might simply join the NPT because they do not plan to acquire nuclear weapons. Indeed, in contrast to ideational explanations, there is
- . The finding that NPT(system effect) is not statistically significant in either stage indicates that the NPT has not curbed proliferation incentives since the 1970s. NPT protocols requiring the dissemination of nuclear knowledge and materials suggest that the NPT may actually contribute to the quickening pace of nuclear diffusion. These results cast doubt on the validity of con strued vist arguments about the transformative effect of international agreements at the system level, at least in the context of nuclear weapons and the NPT.

# STATUS VARIABLE RESULTS

- Major Power Status and Regional Power Status increase the likelihood of having nuclear weapons programs and nuclear weapons, although we do not yet know whether this is the result of realist or identity theories

**Table 2**
**Log-Likelihood Ratio (*LR*) Test**

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| Omitted Independent Variables | Chi-square | Sig. | Chi-square | Sig. |
| Opportunity variables | 61.20 | **** | 42.50 | **** |
| Willingness variables | | | | |
| International security | 8.62 | * | 59.40 | **** |
| Domestic politics | 4.88 | * | 15.63 | **** |
| Norms | 5.54 | * | 0.23 | |
| Status | 53.83 | **** | 52.07 | **** |

Notes: "Opportunity variables" include latent nuclear weapons production capability, economic capacity, and diffusion.
"Willingness variables—International security" include conventional threat, nuclear threat, nuclear defense pact, and diplomatic isolation.
"Willingness variables—Domestic politics" include domestic unrest and democracy.
"Willingness variables—Norms" include NPT membership, NPT system, major power status, and regional power status.
Statistically significant parameter estimators are denoted by * ($p < .10$), ** ($p < .05$), ***($p < .01$), and ****($p < .001$).

**Table 3**
**Effect of Changes in Independent Variables on Probability of Proliferation**

| Independent Variables | Probability | Minimum | Mean | Maximum | Pr. Change | Relative Risk % |
|---|---|---|---|---|---|---|
| Opportunity variables | | | | | | |
| Latent nuclear weapons production capability$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.010 | 0.046 | 0.188 | 0.143 | 313 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.502 | 0.553 | 0.560 | 0.007 | 1 |
| Economic capacity$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.094 | 0.094 | 0.127 | 0.033 | 35 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.391 | 0.907 | 0.999 | 0.092 | 10 |
| Diffusion$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.015 | 0.094 | 0.123 | 0.029 | 30 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.050 | 0.514 | 0.822 | 0.308 | 60 |
| Willingness variables | | | | | | |
| Conventional threat$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.081 | 0.086 | 0.227 | 0.141 | 164 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.477 | 0.557 | 0.880 | 0.323 | 58 |
| Nuclear threat$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.103 | | 0.077 | –0.025 | –25 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.668 | | 0.412 | –0.257 | –38 |
| Nuclear defender$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.096 | | 0.093 | –0.003 | –3 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.615 | | 0.456 | –0.159 | –26 |
| Diplomatic isolation$_{t,t-1,t-5}$ | $Pr(Y_2 = 1)$ | 0.095 | 0.095 | 0.094 | –0.001 | –1 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.549 | 0.553 | 0.562 | 0.009 | 2 |
| Domestic unrest$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.098 | 0.096 | 0.079 | –0.017 | –18 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.546 | 0.552 | 0.571 | 0.019 | 3 |
| Democracy$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.098 | 0.095 | 0.090 | –0.005 | –5 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.492 | 0.553 | 0.615 | 0.062 | 11 |
| NPT membership$_{t,t-1}$ | $Pr(Y_1 = 1)$ | 0.103 | | 0.080 | –0.023 | –23 |
| NPT(system effect)$_{t-1}$ | $Pr(Y_2 = 1)$ | 0.088 | 0.096 | 0.103 | 0.015 | 8 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.585 | 0.553 | 0.530 | –0.055 | –4 |

**Table 3 (continued)**

| Independent Variables | Probability | Minimum | Mean | Maximum | Pr. Change | Relative Risk % |
|---|---|---|---|---|---|---|
| Major power status$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.077 | | 0.210 | 0.133 | 172 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.386 | | 0.902 | 0.516 | 134 |
| Regional power status$_{t,t-1}$ | $Pr(Y_2 = 1)$ | 0.089 | | 0.163 | 0.074 | 83 |
| | $Pr(Y_1 = 1 \mid Y_2 = 1)$ | 0.544 | | 0.589 | 0.046 | 8 |

Notes: $Pr(Y_2 = 1)$ refers to the predicted probability of having nuclear weapons program.
$Pr(Y_1 = 1 \mid Y_2 = 1)$ refers to the predicted conditional probability of possessing nuclear weapons on the condition of having nuclear weapons program.
Probability changes are computed by moving a corresponding variable from mean to maximum for continuous variables or from zero to one for dummy vari-

# CONCLUSIONS

1) States facing major conventional security threats may use nuclear proliferation to countervail disadvantage (Israel and Pakistan).
2) Nuclear defenders do discourage a deepening of nuclear proliferation, but there is not much difference between states possessing or lacking nuclear defenders in terms of the likelihood of having a nuclear weapons program (Romania and South Korea).
3) States facing threats from nuclear powers demonstrate a significantly lower propensity to pursue nuclear programs or weapons proliferation (Cuba)
4) Major powers have been far more likely to develop nuclear weapons programs and nuclear weapons
5) Regional powers are prone to develop programs but are only slightly likelier to produce weapons (Argentina, Brazil, India, and South Africa)
6) Pariah states are neither more likely to initiate nuclear weapons programs nor to possess nuclear weapons. Other considerations appear only marginally to affect states' decisions to pursue proliferation
7) Democracy deepens nuclear proliferation once a nuclear weapons infrastructure is in place, but there is no difference between democracy and autocracy in terms of a tendency to pursue nuclear weapons production programs.

# CONCLUSIONS CONT.

8) Leaders facing domestic unrest or internal bureaucratic pressures to proliferate seldom activate the nuclear card for these reasons (India)
9) Membership in the NPT tends modestly to encourage states to maintain pledges of nonproliferation, while systemic normative constraints of the NPT regime do not exist or are counter acted by the other parties
10) Latent nuclear production capabilities increase the predicted probability of having nuclear weapons programs but that latent production capabilities do not have any substantial impact on the conditional decision to produce nuclear weapons. Thus, latent nuclear capability is a critical factor early in proliferation but less so later on.
11) The diffusion of nuclear knowledge and technology eases opportunity barriers to the proliferation of programs and nuclear weapons