

Alliance Participation, Treaty Depth and Military Spending

Joshua Alley

September 10, 2019

Texas A&M University

Treaty depth constrains free-riding in alliances by non-major powers.

What Does That Mean?

- **Depth:** The extent of military cooperation an alliance treaty promises.

What Does That Mean?

- **Depth:** The extent of military cooperation an alliance treaty promises.
- **Free-riding:** Low defense spending by alliance participants.

What Does That Mean?

- **Depth:** The extent of military cooperation an alliance treaty promises.
- **Free-riding:** Low defense spending by alliance participants.
- **Non-major powers:** Countries with less capability and ambition in international politics.

Why Should You Care?



**Does alliance participation
increase military spending?**

**Does alliance participation
increase military spending?
Or decrease it?**

Competing Results

	Decrease	Increase	Null
Most & Siverson 1987			X
Conybeare 1994	X		
Diehl 1994		X	
Goldsmith 2003			X
Morgan & Palmer 2006		X	
Quiroz-Flores 2011		X	

Omission: Alliance Heterogeneity

- Alliances can *increase or decrease* military spending.

Omission: Alliance Heterogeneity

- Alliances can *increase or decrease* military spending.
- Depends on alliance characteristics.

**Treaty depth is a key sources of
differences between alliances.**

I make my claim about alliance participation and military spending in three ways:

I make my claim about alliance participation and military spending in three ways:

1. Argument: Treaty Depth and Non-Major Powers

I make my claim about alliance participation and military spending in three ways:

1. Argument: Treaty Depth and Non-Major Powers
2. Statistical Analysis

I make my claim about alliance participation and military spending in three ways:

1. Argument: Treaty Depth and Non-Major Powers
2. Statistical Analysis
3. Evidence from US alliances

Argument

The Problem of Free-riding

Alliances are a form of international cooperation. Free-riding means alliance members:

The Problem of Free-riding

Alliances are a form of international cooperation. Free-riding means alliance members:

1. Rely on partners for protection and

The Problem of Free-riding

Alliances are a form of international cooperation. Free-riding means alliance members:

1. Rely on partners for protection and
2. Reduce defense spending.

Deep alliances restrain free-riding.

Treaty Depth

Deep treaties stipulate extensive defense cooperation.

Deep treaties stipulate extensive defense cooperation.

1. **Primary Obligations**

- Whether the alliance promises military support and conditions on that support.

Deep treaties stipulate extensive defense cooperation.

1. **Primary Obligations**

- Whether the alliance promises military support and conditions on that support.

2. **Formal defense cooperation:**

Deep treaties stipulate extensive defense cooperation.

1. **Primary Obligations**

- Whether the alliance promises military support and conditions on that support.

2. **Formal defense cooperation:**

- Bases, policy coordination, military aid, side agreements, formal institutions.

Limits on Free-Riding

There are two ways depth limits alliance members ability to free-ride.

Limits on Free-Riding

There are two ways depth limits alliance members ability to free-ride.

1. Greater alliance value.

Limits on Free-Riding

There are two ways depth limits alliance members ability to free-ride.

1. Greater alliance value.
2. Greater allied leverage.

Depth is relevant for non-major powers because they are more prone to free-ride.

Non-Major Powers

- Emphasize immediate security.

Non-Major Powers

- Emphasize immediate security.
- Constraint: Opportunity Costs of Military Spending.

Non-Major Powers

- Emphasize immediate security.
- Constraint: Opportunity Costs of Military Spending.
- Alliance participation usually *decreases* military spending.

Hypothesis 1: As alliance treaty depth increases, growth in non-major power military spending from alliance participation will increase.

Empirical Analysis

I need two things to test the prediction:

I need two things to test the prediction:

1. Measure of treaty depth— measurement model.

I need two things to test the prediction:

1. Measure of treaty depth— measurement model.
2. Connect alliance-level variation with state-level outcomes— multilevel analysis.

Measuring Treaty Depth

I use a latent variable model to infer treaty depth from observed promises.

Measuring Treaty Depth

I use a latent variable model to infer treaty depth from observed promises.

My measure of depth for each alliance is the posterior mean of a latent factor.

Details of Measure

- Multiple observed indicators of depth (ATOP):
 - *Primary Obligations*: offense, defense, neutrality, consultation, non-aggression, unconditional military support.
 - *Defense Cooperation*: bases, integrated command, military aid, IO formation, defense policy coordination, other military agreements.

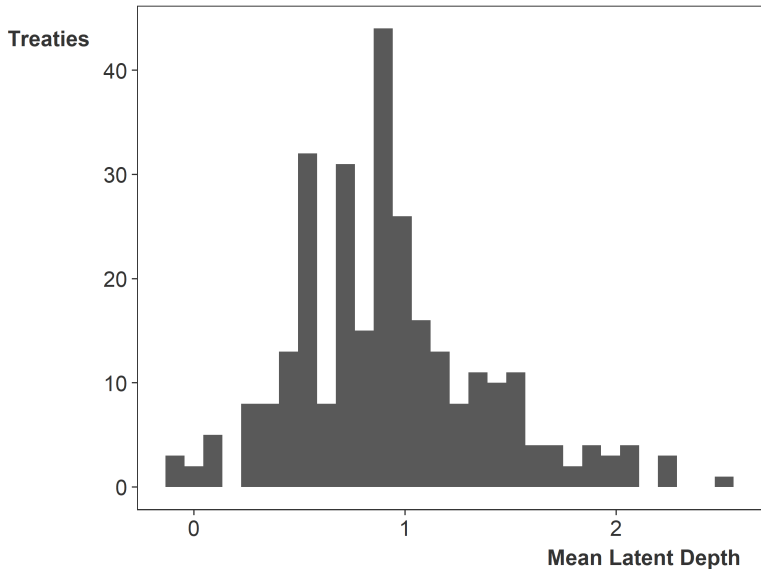
Details of Measure

- Multiple observed indicators of depth (ATOP):
 - *Primary Obligations*: offense, defense, neutrality, consultation, non-aggression, unconditional military support.
 - *Defense Cooperation*: bases, integrated command, military aid, IO formation, defense policy coordination, other military agreements.
- Semiparametric mixed factor analysis. (Murray et al 2013)

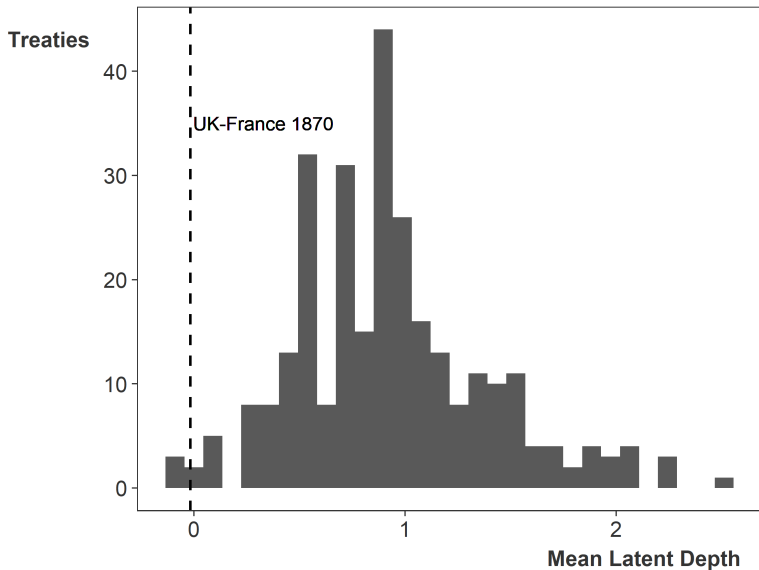
Details of Measure

- Multiple observed indicators of depth (ATOP):
 - *Primary Obligations*: offense, defense, neutrality, consultation, non-aggression, unconditional military support.
 - *Defense Cooperation*: bases, integrated command, military aid, IO formation, defense policy coordination, other military agreements.
- Semiparametric mixed factor analysis. (Murray et al 2013)
- Generates a posterior distribution of depth for each alliance.

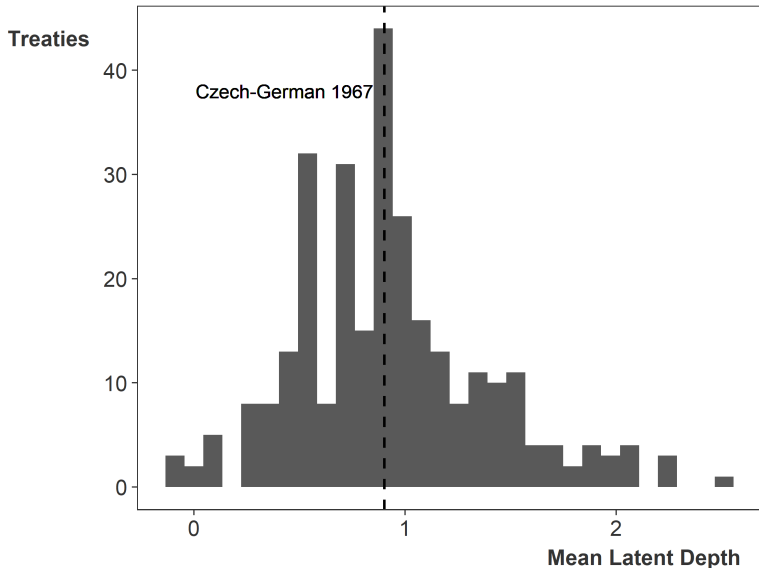
Latent Measure of Treaty Depth



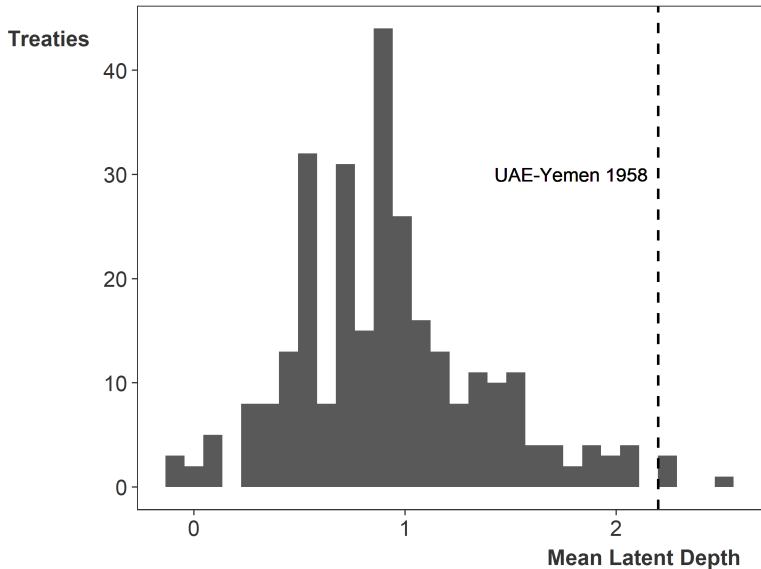
Latent Measure of Treaty Depth: Shallow



Latent Measure of Treaty Depth: Typical



Latent Measure of Treaty Depth: Deep



Empirical Analysis: Multilevel Model

- Link alliance-level variation with state-level outcomes.

Empirical Analysis: Multilevel Model

- Link alliance-level variation with state-level outcomes.
- Two connected regressions: alliance and state-level.

Empirical Analysis: Multilevel Model

- Link alliance-level variation with state-level outcomes.
- Two connected regressions: alliance and state-level.
- Alliance characteristics modify the association between alliance membership and spending growth.

$$\begin{array}{ccccccc} \text{Growth} = & & \text{Varying} & + & \text{State} & + & \text{Alliance} \\ \text{Mil. Ex.} & & \text{Intercepts} & & \text{Vars.} & & \text{Participation} \end{array}$$

$$\text{Growth} = \text{Mil. Ex.} + \text{Varying Intercepts} + \text{State Vars.} + \text{Alliance Participation}$$

Alliance
Characteristics
↓

ML Model

$$\begin{array}{ccccccc} & & & & & \text{Alliance} & \\ & & & & & \text{Characteristics} & \\ & & & & & \lambda = \alpha_{all} + \beta_1 \text{Depth} + \mathbf{X}\beta & \\ & & & & & \downarrow & \\ \text{Growth} = & \text{Varying} & + & \text{State} & + & \text{Alliance} & \\ \text{Mil. Ex.} & \text{Intercepts} & & \text{Vars.} & & \text{Participation} & \\ y = & \alpha + \alpha^{st} + \alpha^{yr} & + & \mathbf{W}\gamma & + & \mathbf{Z}\lambda & \end{array}$$

ML Model Specification

$$y \sim \text{student}_t(\nu, \mu, \sigma) \quad (1)$$

$$\mu = \alpha + \alpha^{st} + \alpha^{yr} + \mathbf{W}_{n \times k} \gamma + \mathbf{Z}_{n \times a} \lambda \quad (2)$$

$$\lambda_a \sim N(\theta_a, \sigma_{all}) \quad (3)$$

$$\theta_a = \alpha_{all} + \beta_1 \text{Treaty Depth} + \mathbf{X}_{a \times l} \beta \quad (4)$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Miley. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Miley. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Milex. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Miley. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Miley. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Miley. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

Example

$$\mu_{it} = \alpha + \alpha^{st} + \alpha^{yr} + W_{it}\gamma + Z_{it}\lambda$$

Example year: Argentina 1955

1955 Growth Miley. = Overall mean

+ Argentine Intercept + 1955 Intercept

+ Argentine Characteristics

+ λ_{OAS} * OAS Expenditure + λ_{Rio} * Rio Pact Expenditure

$$\lambda_{Rio} = \alpha_{all} + \beta_1 0.34 + \text{Controls}$$

State-Year	Rio Pact	Warsaw Pact
Argentina 1954	.347	0
Argentina 1955	.418	0
⋮	⋮	⋮

Sample and Key Variables

- **Sample:** Non-major power states (COW)— 1816-2007.
193 Alliances with military support.

Sample and Key Variables

- **Sample:** Non-major power states (COW)— 1816-2007.
193 Alliances with military support.
- **DV:** Growth in military spending (COW)
$$= \frac{\Delta \text{Mil. Expend}_t}{\text{Mil. Expend}_{t-1}}$$

Sample and Key Variables

- **Sample:** Non-major power states (COW)— 1816-2007.
193 Alliances with military support.
- **DV:** Growth in military spending (COW)
$$= \frac{\Delta \text{Mil. Expend}_t}{\text{Mil. Expend}_{t-1}}$$
 - Transformed with Inverse Hyperbolic Sine.

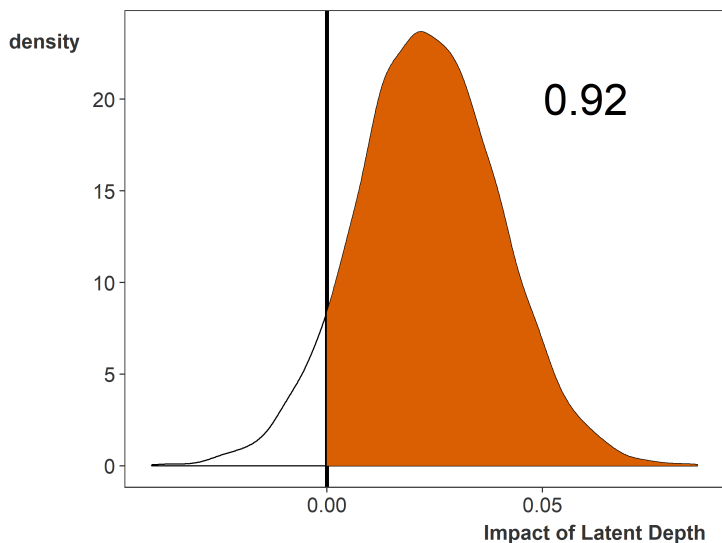
Sample and Key Variables

- **Sample:** Non-major power states (COW)— 1816-2007.
193 Alliances with military support.
- **DV:** Growth in military spending (COW)
$$= \frac{\Delta \text{Mil. Expend}_t}{\text{Mil. Expend}_{t-1}}$$
 - Transformed with Inverse Hyperbolic Sine.
- **Alliance-Level IV:** Mean treaty depth

- **State-Level Controls:** Interstate war, civil War, annual MIDs, GDP growth, POLITY, Cold War, rival military expenditures.

- **State-Level Controls:** Interstate war, civil War, annual MIDs, GDP growth, POLITY, Cold War, rival military expenditures.
- **Alliance-Level Controls:** Share of democracies, number of members, wartime, asymmetric obligations, US member (Cold War), USSR member.

Association Between Treaty Depth and Growth in Military Spending



Post. Mean Median Growth

Importance

Post. Mean	Median Growth
0.02	0.06

Importance

Post.	Mean	Median	Growth
-------	------	--------	--------

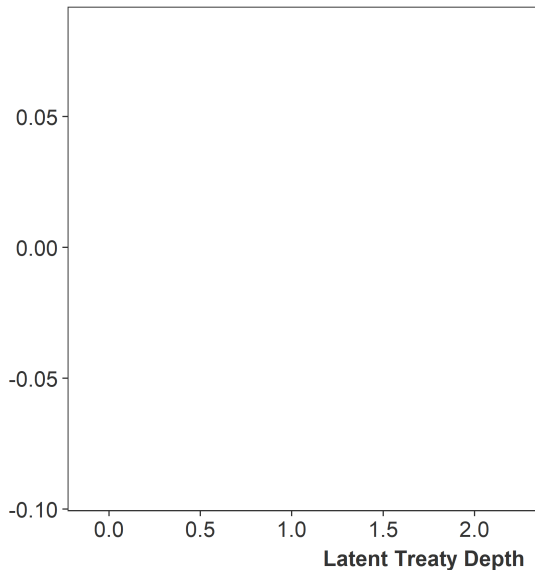
0.02			
------	--	--	--

	0.06		
--	------	--	--

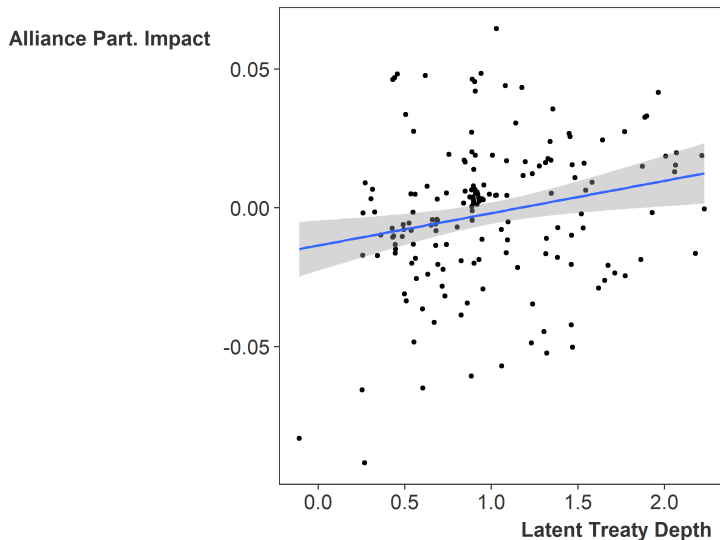
US spent \$36.0 billion on NATO in 2018, or 5.5% of the total defense spending.

Treaty Depth and λ

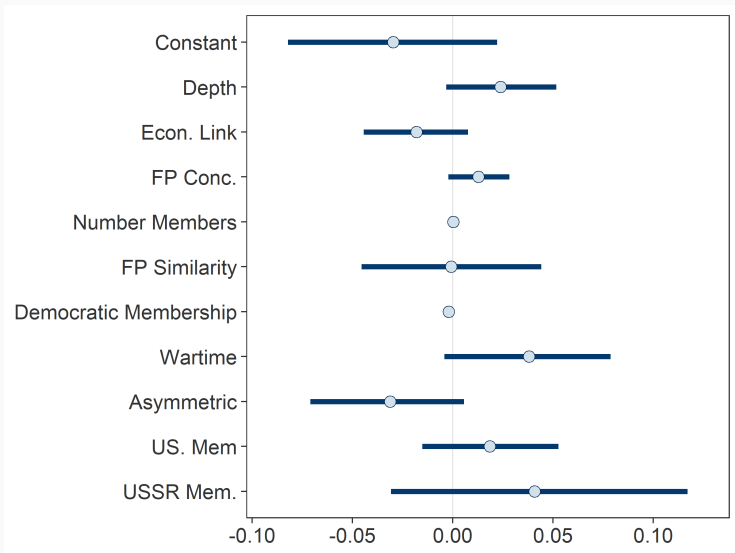
Alliance Part. Impact



Treaty Depth and λ : Non-major Powers



Treaty Depth and Other Alliance Characteristics



US Alliances

Foreign Entanglement and Shallow Formal Obligations

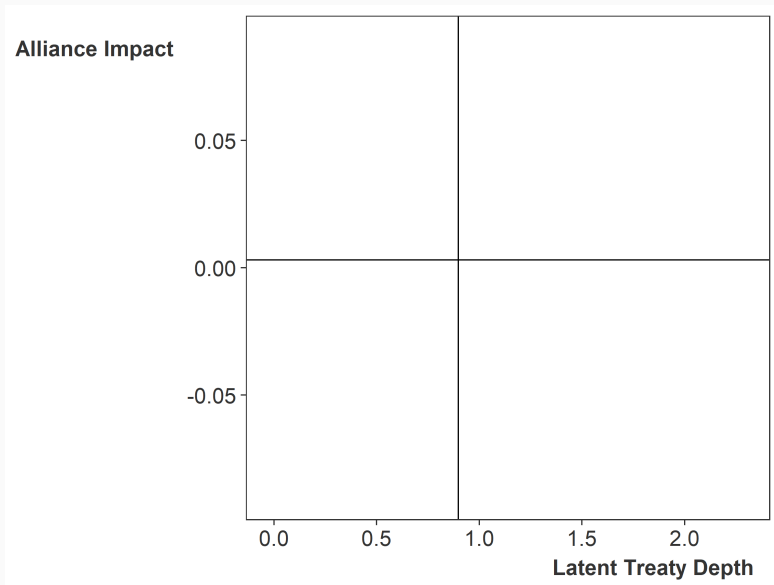


**“The Parties agree that an armed attack
against one or more of them in Europe or
North America shall be considered an attack
against them all...”**

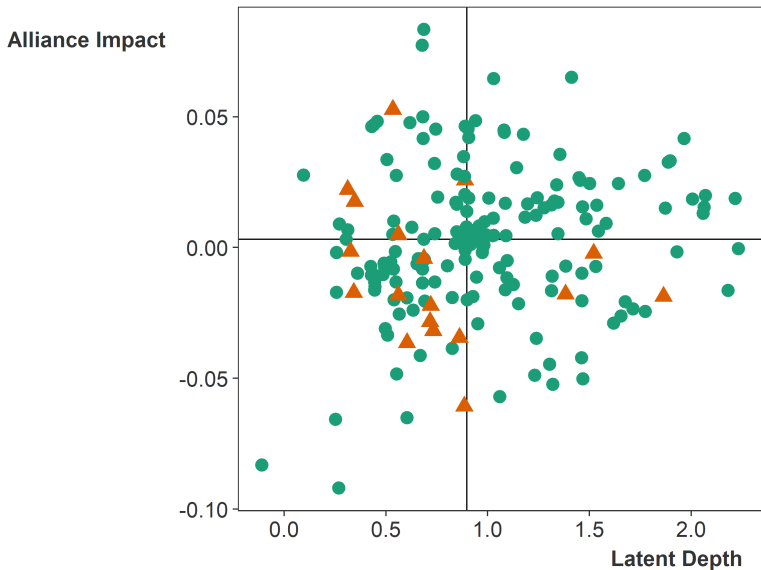
“assist the Party or Parties so attacked by taking forthwith, individually and in concert with the other Parties, such action as it deems necessary, including the use of armed force”

**“such action as it deems
necessary, including the
use of armed force”**

US Alliances in Context



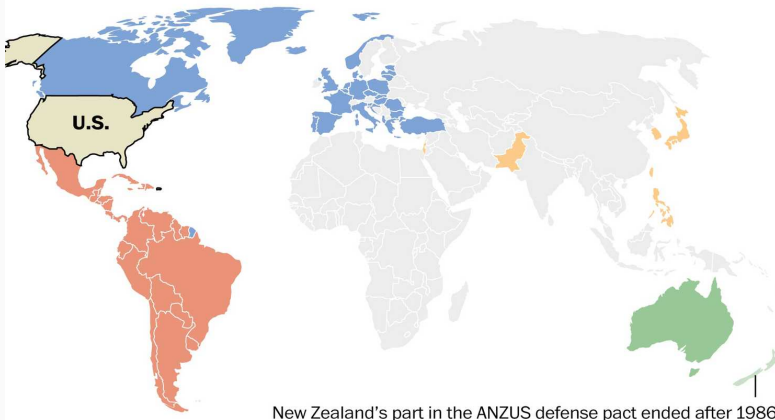
US Alliances in Context



Implication: What to do with US alliances?

US defense pacts, 1947–2014

● OAS ● NATO ● ANZUS ● Bilateral



Note: OAS stands for Organization of American States; NATO for North Atlantic Treaty Organization; and ANZUS for Australian, New Zealand, United States Security Treaty.

Source: Belfer Center of Harvard University, CIA

THE WASHINGTON POST

Conclusion

**How alliance participation affects
military spending depends on treaty
depth.**

Though alliance participation usually decreases non-major power military spending, growth is higher in deep treaties.

Looking Ahead

My dissertation articulates and tests a more general theory of alliance participation and military spending.

My Research Agenda

The political economy of security, with a focus on formal institutions.

International Security

- Alliance Participation, Treaty Depth and Military Spending
- Reassessing the Public Goods Theory of Alliances

Intra-State Conflict

- Conflict Management Institutions and FDI
- Sanctioning Terrorist Groups: Can it Work?
- Weapon of the Weak?: Rebel Groups' International Law Talk, 1974-2011

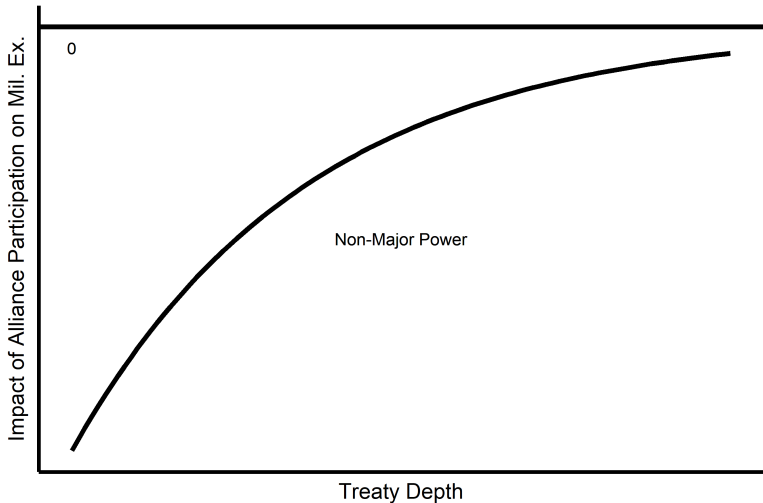
Thank you!

jkalley14@tamu.edu

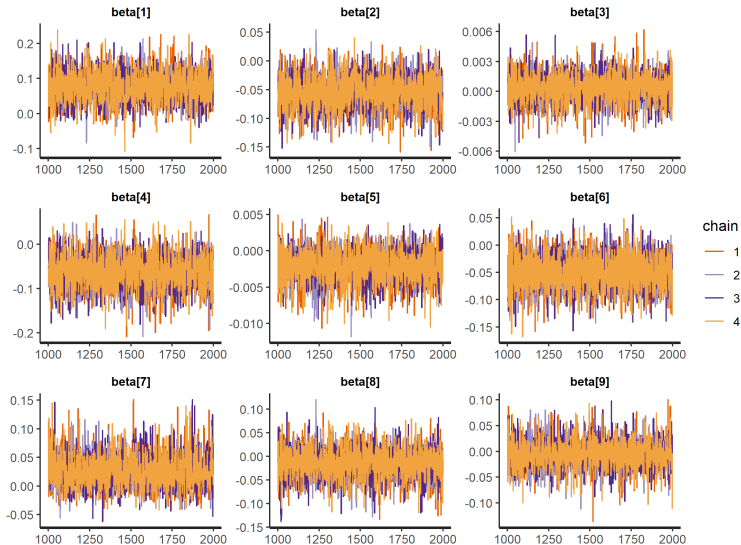
Limitations

1. Domestic political economy of military spending.
2. Measurement error and missing data.
3. Formal depth only in the measure.
4. Strategic alliance design

Spending Growth and the Hypotheses



Trace plots: Non-Major



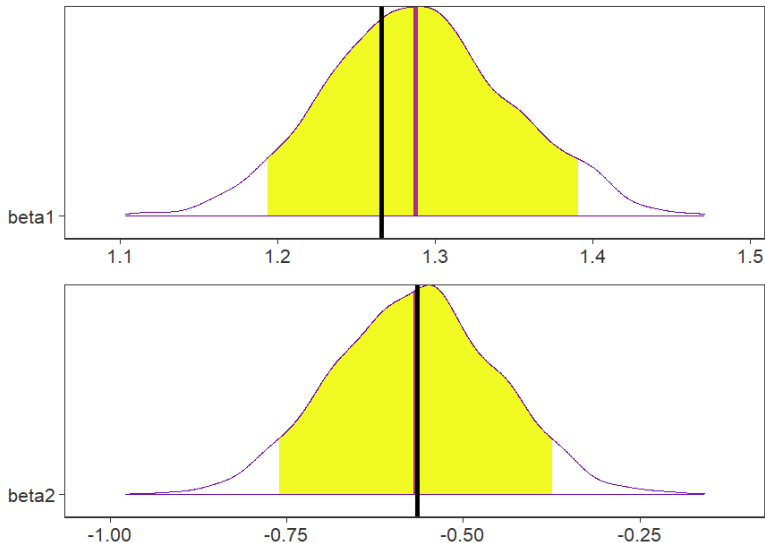
Model Check: Recovering Known Parameters

Another way to check complicated models is simulating fake data with known parameters, then using the model to recover said parameters.

To check my model, I simulated a fake dataset of 2,000 observations with 50 states, 200 years, 100 alliances and 2 variables at each level.

The 90% credible intervals contain the known value for all regression parameters. 93 of 100 alliance specific parameter intervals contain the known value.

Simulated Parameters and Credible Intervals



Alliance-Level Regression Table: Non-Major Powers

8,668 observations and 192 alliances.

	mean	sd	5%	95%	n_eff	\hat{R}
Constant	-0.03	0.03	-0.08	0.02	1677.92	1.00
Depth	0.02	0.02	-0.00	0.05	2521.36	1.00
Econ. Link	-0.02	0.02	-0.04	0.01	2997.70	1.00
FP Conc.	0.01	0.01	-0.00	0.03	4019.10	1.00
Number Members	0.00	0.00	-0.00	0.00	3820.06	1.00
FP Similarity	0.00	0.03	-0.04	0.05	2254.34	1.00
Democratic Membership	-0.00	0.00	-0.00	0.00	4412.89	1.00
Wartime	0.04	0.03	-0.01	0.08	3474.44	1.00
Asymmetric	-0.03	0.02	-0.07	0.01	3474.45	1.00
US. Mem	0.02	0.02	-0.01	0.05	2330.47	1.00
USSR Mem.	0.04	0.05	-0.03	0.12	3859.50	1.00
σ Alliances	0.02	0.01	0.00	0.03	1201.91	1.01

Priors

4 Chains with 2,000 samples and 1,000 warmup iterations.

$$p(\alpha) \sim N(0, 1)$$

$$p(\sigma) \sim \text{half-}N(0, 1)$$

$$p(\alpha^{yr}) \sim N(0, \sigma^{yr})$$

$$p(\sigma^{yr}) \sim N(0, 1)$$

$$p(\alpha^{st}) \sim N(0, \sigma^{st})$$

$$p(\sigma^{st}) \sim \text{half-}N(0, .5)$$

$$p(\sigma^{all}) \sim \text{half-}N(0, .5)$$

$$p(\beta) \sim N(0, .5)$$

$$p(\gamma) \sim N(0, .5)$$

$$p(\nu) \sim \text{gamma}(2, 0.1)$$

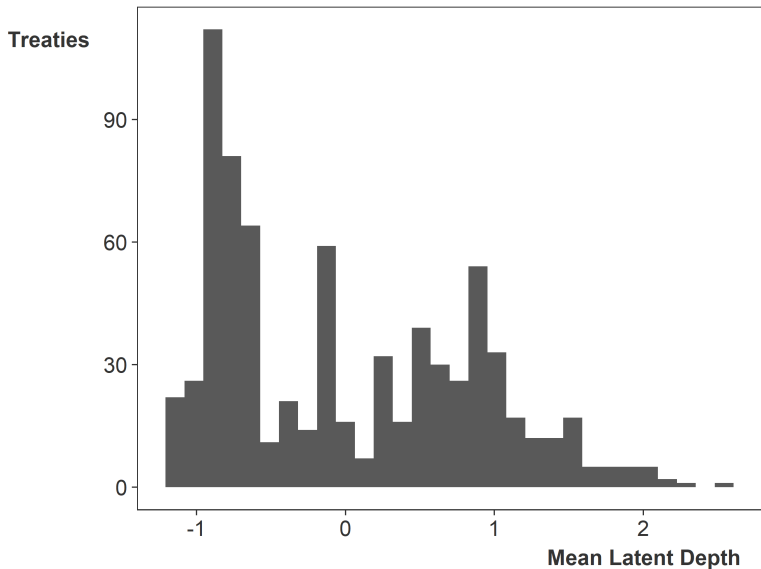
Details of Measurement Model

- Bayesian Gaussian Copula Factor Model: for mixed data.
- Uses copulas to break dependence between latent factors and marginal distributions.
- Treats marginals as unknown and keeps them free of dependence.
- IMH proposal, 10,000 iteration warmup, 20,000 samples, thinned every 20 draws.
- Generalized double Pareto prior for the factor loading—flexible generalized Laplace distribution with a spike at zero and heavy tails.

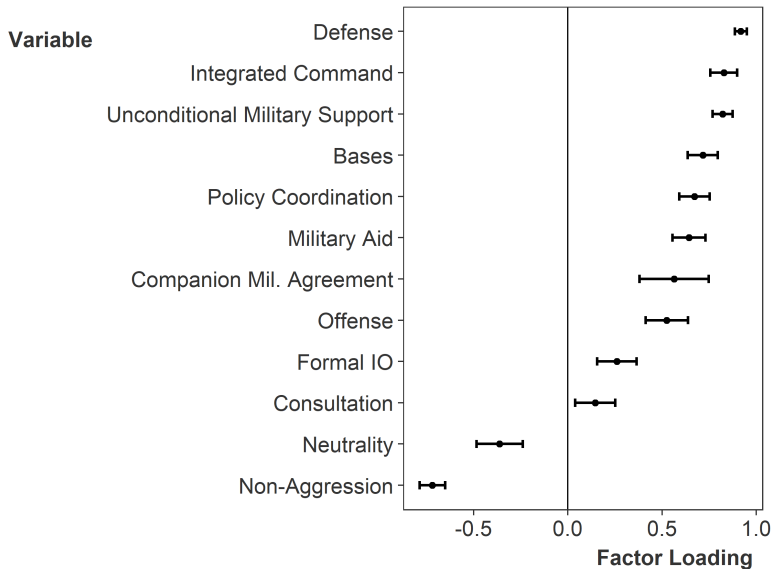
Aside: Benson and Clinton 2016

- Use a measurement model to infer alliance scope, depth and capability.
- Identify three separate dimensions, and use three models-explicit constraint.
- I use a different concept, which combines what they call scope and depth.
- Murray et al's model relaxes distributional assumptions in their estimator (Quinn 2004 Factor Analysis).

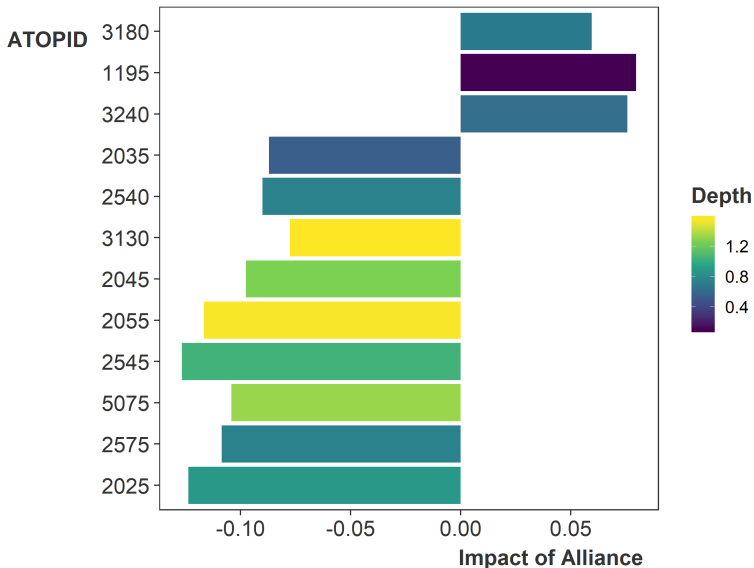
Latent Measure for all ATOP Alliances



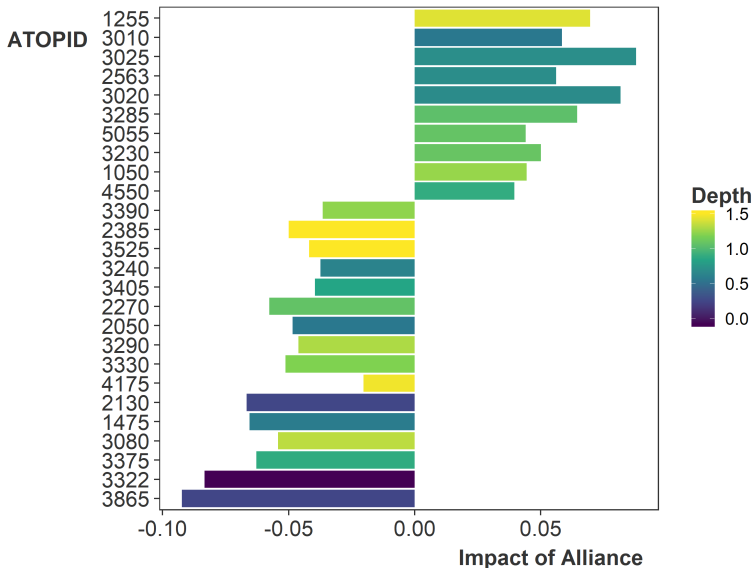
Factor Loadings



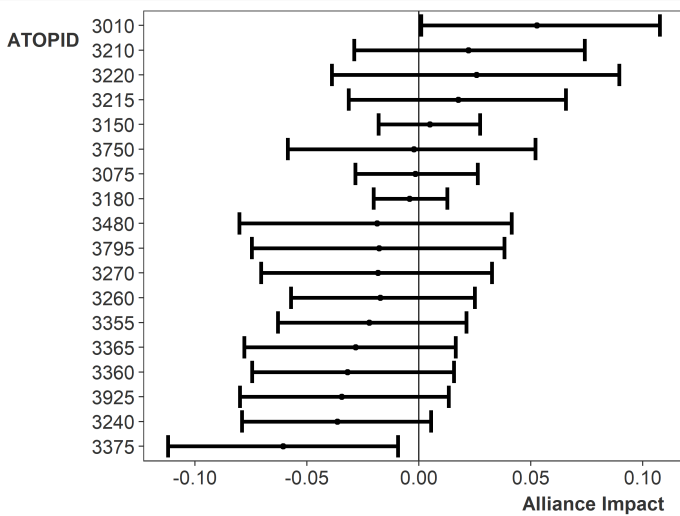
Notable Major Power Alliances



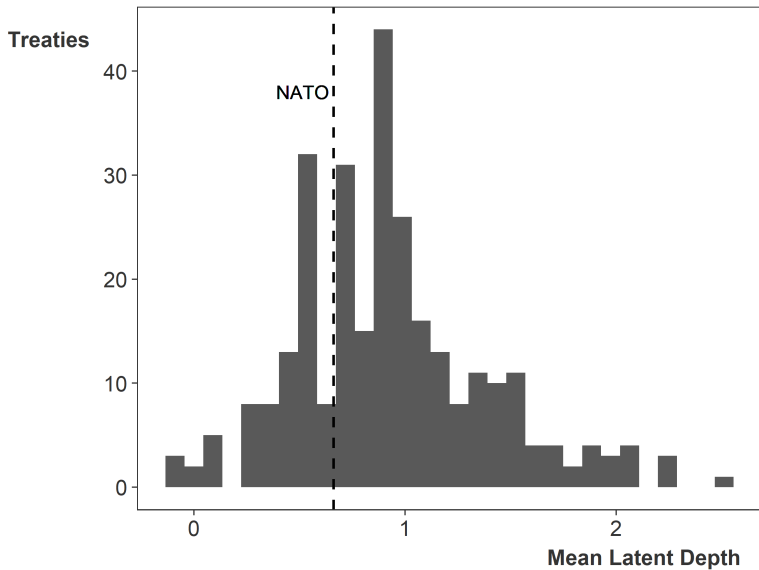
Notable Non-Major Power Alliances



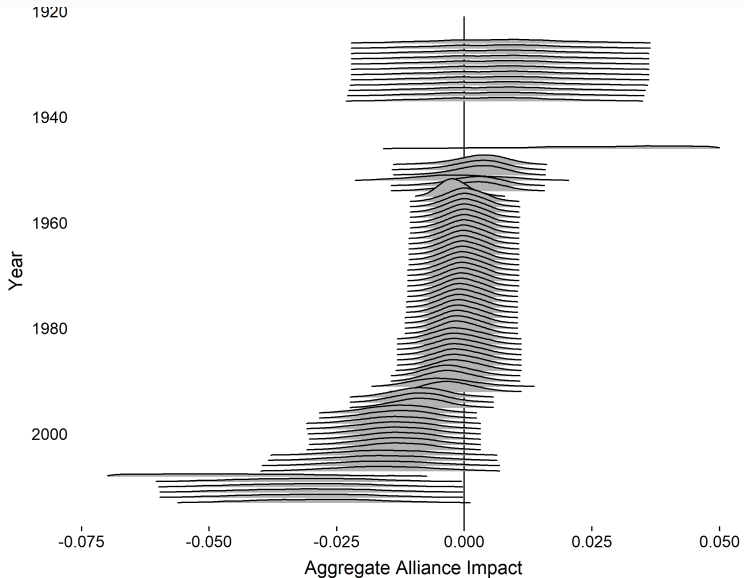
Impact of US Alliance on Non-major Power Military Spending



NATO

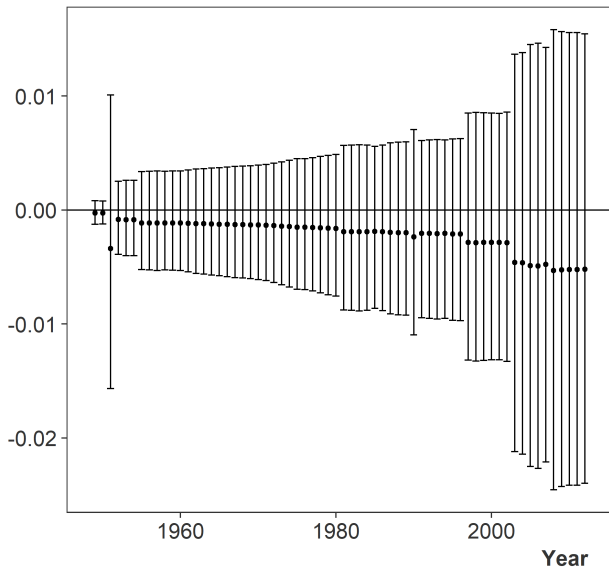


Non-Major Powers in NATO: Belgium

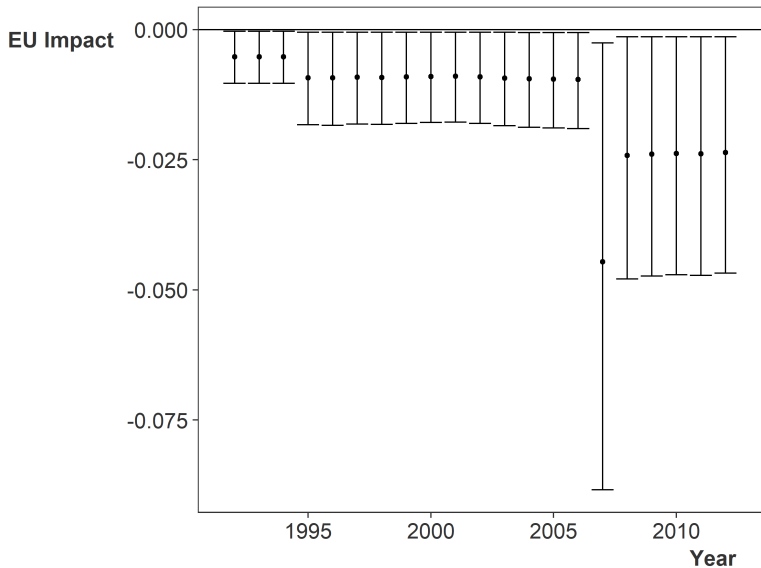


Impact of NATO on Belgium

NATO Impact



Impact of EU on Belgium



Varying Slopes Model

Within each of the j groups of state capability, for i in $1 \dots n_j$:

$$y_i \sim \text{student}_t(\nu_j, \alpha_j + \alpha^{st} + \alpha^{yr} + \mathbf{W}_i \gamma + \mathbf{Z}_{ji} \lambda_j, \sigma_j)$$

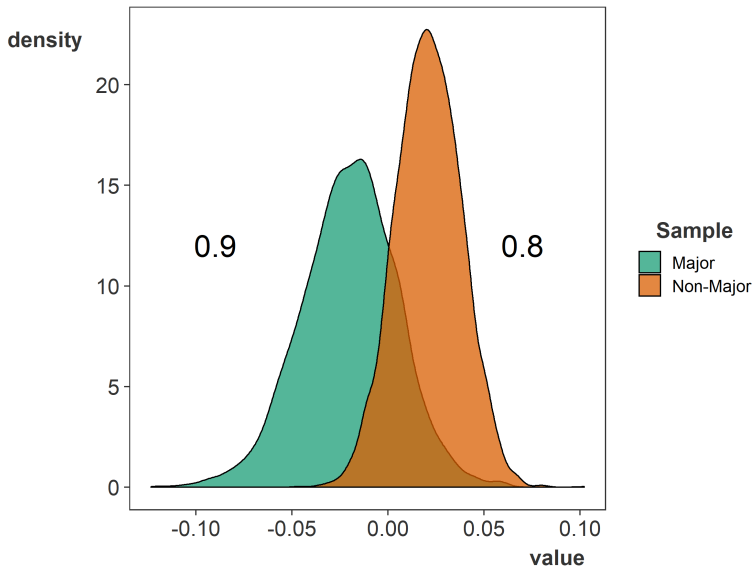
$$\lambda_j \sim N(\theta_j, \sigma_j^{all})$$

$$\theta_j = \alpha_j^{all} + \mathbf{X} \beta_j$$

I give β_j a multivariate normal prior with prior scale τ :

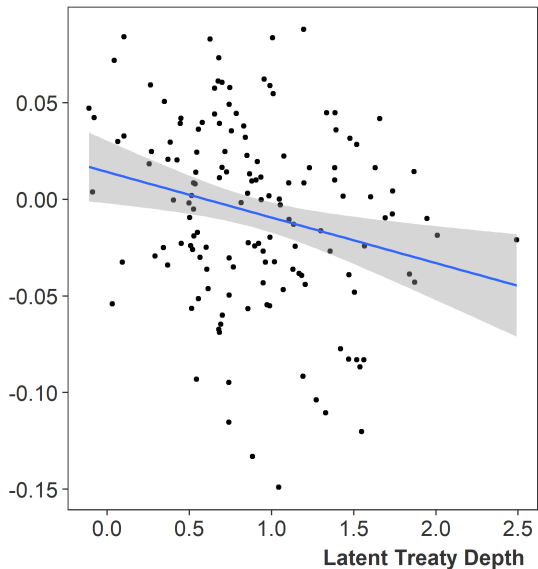
$$\beta_j \sim \text{MVN}(\mu_{\beta_j}, \Sigma_{\beta})$$

Varying Slopes Results: Depth

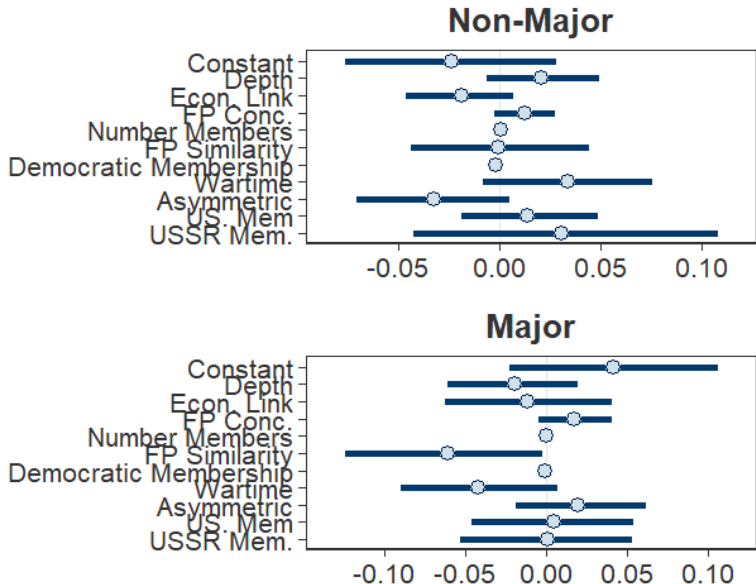


Treaty depth and λ : Major Powers

Alliance Part. Impact



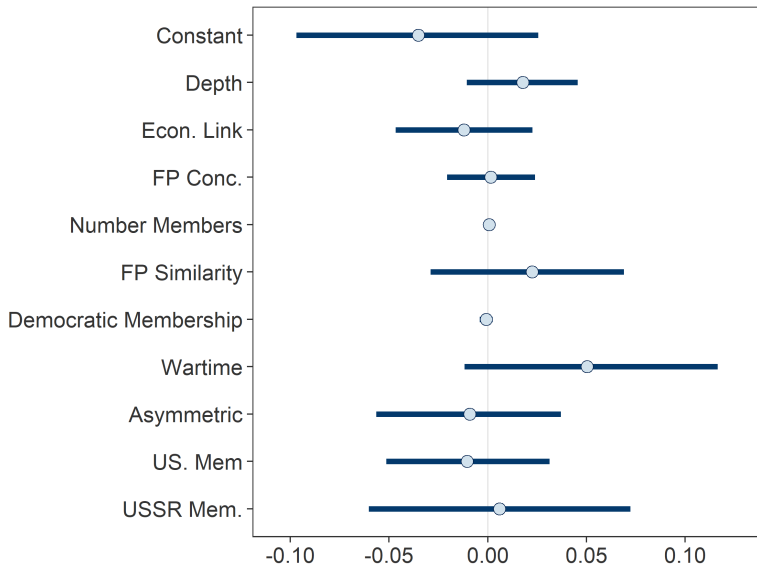
Full Varying Slopes Results



Alternative Measure of Military Spending

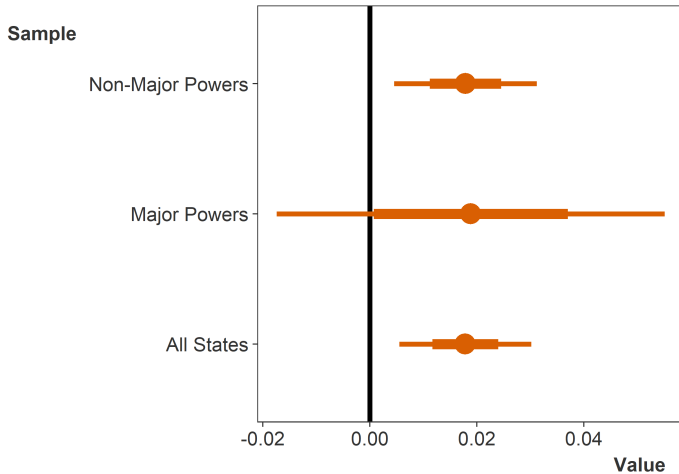
- Nordhaus et al 2012 data: mix of COW and SIPRI- fully rebased
- 1949 to 2001
- Same model: use changes in spending instead of growth.

Alternative Measure of Military Spending: Results



Single-Level Regression

Robust regression: Independent variable is average depth of a state's alliances.



Bounds Analysis of Single-Level Regression

