Alliance Participation and Military Spending

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Abstract

How does alliance participation change military spending? Previous answers to this question are divided between assertions alliance participation increases or decreases military spending. I argue alliance participation can raise or lower growth in military expenditures, depending on treaty strength and state size. Greater treaty strength reduces growth in major power military spending because major powers use alliances for international influence. Reduced growth for non-major powers alliance powers in attenuated under strong treaties because strong treaties give allies more influence. I test this argument by creating a measure of alliance treaty strength and employing that measure in a multilevel model. The research design generates novel empirical evidence linking alliance participation and growth in state military spending from 1816 to 2007. I find that greater treaty strength increases growth in military spending in non-major powers and decreases spending growth for major powers.

1 Introduction

How does alliance participation affect military spending? Scholarship on this issue is divided between two camps. The force multiplier perspective expects alliance participation to reduce military spending. The foreign entanglement group predicts alliance participants will spend more on defense.

In this paper, I address the division between these two perspectives on alliance participation and military expenditures. I show when alliance participation increases and decreases growth in military expenditures, making theoretical and empirical contributions. I argue that major and non-major power states use alliances for different purposes, so they respond differently to changes in treaty strength.

Major powers use alliances to increase their influence. Strong treaties replace military spending as a source of influence, allowing large states to reduce growth in military expenditures from alliance participation. Non-major powers emphasize territorial security from alliances. These small

states sacrifice the freedom to reduce military spending for greater security under a strong treaty. Weaker treaties still provide security without tying military support to other costly commitments, giving non-major powers the chance to reduce military spending.

I test these predictions with a novel research design. First I develop a latent measure of alliance treaty strength. I then incorporate that measure into a multilevel model which estimates the impact of specific alliance treaty characteristics, and aggregate impact of each treaty on growth in military spending. Multilevel modeling links the alliance and state levels of analysis, showing how changes in treaty strength affects state military spending.

Unifying scholarship on alliance participation and military spending has academic and practical value. Force entanglement and force multiplier arguments treat alliances and states as homogeneous.[1] But there is substantial variation in alliance membership and treaty content (Leeds et al., 2002). Therefore, mutually exclusive claims alliance participation increases or decreases military spending may be misleading.

Dissension between the foreign entanglement and force multiplier camps provides poor guidance for policy discussions. Policy debates emphasize reduced spending by alliance members—especially US allies. But the US and other democracies make weaker formal commitments, and other kinds of treaties could have different effects. My argument makes distinctions between treaties, adding nuance to policy discussions.

Alliance treaty design has distributional consequences in domestic and international politics. Treaty strength shapes how large and small alliance members allocate resources to the military. Large and small members will bear different security burdens under different treaties.

Growth in military spending has domestic opportunity costs— funds spent on security cannot be spent on other goods. Greater military spending impacts economic growth (Shin and Ward, 1999; Alptekin and Levine, 2012) and domestic politics (Narizny, 2003; Whitten and Williams, 2011; Williams, 2015).

[1] See DiGiuseppe and Poast (2016) for an important exception.

Another implication of this argument is that major and minor powers face different tradeoffs in alliance politics, Strong commitments give major powers more influence but lead to greater entanglement abroad. For non-major powers, strong treaties provide more security at the cost of freedom to reduce military spending.

The paper proceeds as follows. First, I summarize competing arguments and mixed empirical evidence on alliance participation and military spending. Then I describe my state size and treaty strength argument in more detail. The third and fourth sections describe the research design and results. The final section concludes with a discussion of the implications for scholarship and policy.

2 Force Multiplier or Foreign Entanglement?

Scholarship on alliance participation and military spending is divided between two perspectives. The foreign entanglement view predicts alliance participation will increase military expenditures. The force multiplier school expects alliance participation will reduce military spending.

2.1 Force Multiplier

Force multiplier arguments start with the premise alliances and military spending both provide security. States substitute between these two foreign policy instruments (Most and Starr, 1989). Alliances provide security that states could not achieve without additional military spending (Morrow, 1993; Conybeare, 1994). Because military spending has opportunity costs, states rely on their allies for security and and reallocate military spending to other goods.

Allied military capability replaces defense expenditures of member states. DiGiuseppe and Poast (2016) refine the substitution logic by arguing that states will only reduce spending if the alliance is credible. Unreliable alliance capability cannot replace reliable domestic military spending.

Another argument in the force multiplier perspective links reduced military spending to a col-

lective action problem. Olson and Zeckhauser (1966) argue that security from an alliance is a public good, so treaty members provide inadequate contributions of military spending. Each member free-rides on other states, and smaller members exploit larger states. Spending less allows alliance members to consume more non-defense goods, but the alliance provides suboptimal security.

Both the substitution and public goods models expect alliance participation will reduce spending. These arguments are rooted in the opportunity costs of military spending. But the foreign entanglement group predicts alliance participation increases military expenditures, because alliances provide more than security.

2.2 Foreign Entanglement

The foreign entanglement perspective is less cohesive. Most of these arguments emphasize non-security benefits of alliance participation. States then use additional military expenditures to reinforce gains from alliance participation.

Diehl (1994) argues that alliances increase foreign policy obligations, necessitating extra military spending. Because alliances expand what a state can achieve in international relations, states will increase military spending to pursue other foreign policy goals (Morgan and Palmer, 2006). Horowitz, Poast and Stam (2017) show that buffer states increase defense effort to make themselves a more attractive alliance partner, which is a more security-focused argument. Others assert that alliances generate cooperation, leading to higher defense spending (Palmer, 1990; Quiroz Flores, 2011) Last, Senese and Vasquez (2008) argue that military spending and alliances are part of a conflict spiral that produces simultaneous growth in military expenditures and alliance participation.

Arguing alliances do more than provide security is a crucial insight. However, the foreign entanglement perspective does not consider the opportunity costs of military spending. If military spending has opportunity costs, states have incentives to reduce spending where possible. Likewise, the force multiplier perspective does not acknowledge synergies between military spending

and alliances. This divergence carries over into testing both predictions.

2.3 Mixed Evidence

The force mutliplier or foreign entanglement dispute could be settled by a preponderance of empirical evidence. Unfortunately, the divided state of theory is reinforced by mixed empirical results.[2] Some studies find a positive association between alliance participation and military spending. Others find a negative relationship.

The wide range of methodologies and samples in previous research can be divided into into specific and general research designs. Specific studies examine the impact of a few alliances, usually by tracking how a state responds to the military spending of a key ally. General studies compare many states through dummy indicators of alliance participation. Each design has different virtues and shortcomings.

Specific designs have more detail on treaties, but lack generalizability. Most support for the substitution of arms and alliances comes from specific designs (Barnett and Levy, 1991; Morrow, 1993; Sorokin, 1994; Plümper and Neumayer, 2015). But other specific studies find increased spending by alliance members (Conybeare and Sandler, 1990; Chen, Feng and Masroori, 1996).

General models capture a wide range of state-year observations and compare states with an alliance to those without. Dummy indicators of alliance participation in a general study combine diverse treaties in a state-level measure. Therefore, general studies do not distinguish between alliances, omitting crucial differences between treaties.

Table 1 summarizes previous results from general models of alliance participation and military spending. General research designs also produce mixed results. There are two negative, four positive and two null estimates of the correlation between alliance participation and spending.

Mixed results are the result of inadequate attention to differences between alliance treaties and

[2]Because tests of the public goods model regress military spending as a share of GDP on GDP, I ignore most tests of that theory while summarizing prior results. That research design suffers from an identification problem.

	Decrease	Increase	Null
Most and Siverson (1987)			X
Conybeare (1994)	X		
Diehl (1994)		X	
Goldsmith (2003)			X
Morgan and Palmer (2006)		X	
Quiroz Flores (2011)		X	
DiGiuseppe and Poast (2016)	X		
Horowitz, Poast and Stam (2017)		X	

Table 1: General Findings of Association Between Alliance Participation and Military Spending.

participants. There is substantial heterogeneity among alliances. Treaties vary in their obligations, membership, and capability. Alliance heterogeneity makes it difficult to infer general relationships from specific studies, and undermines binary measures of alliance participation in general studies.

Second, alliance members have different goals. Some states have extensive foreign policy ambitions, while others focus on defending their territory. My argument incorporates alliance heterogeneity and differences in member size to explain how alliance participation is associated with military spending.

3 Argument

This argument predicts growth in military spending. Annual growth in spending is equal to changes in spending as a share of the previous year's budget. So growth in military expenditures is calculated as:

$$\text{Growth Mil. Expend} = \frac{\text{Change Mil. Expend}_t}{\text{Mil. Expend}_{t-1}} \tag{1}$$

While most studies focus on changes or levels of military expenditures, growth in military spending is a better outcome measure. Military spending has a "ratchet effect" where increases are rarely offset by decreases. The level of military spending rises over time for most states, especially in longer panels. Because growth is calculated relative to prior expenditures, it facilitates

comparisons across diverse states and time periods. Using growth in spending in regression models also limits the risk of spurious inferences from non-stationarity in military spending.

Predicting growth in military expenditures changes the interpretation of alliance participation. Only negative growth in spending reduces the level of military expenditures. Alliance participation can lower the growth of defense budgets without reducing the level of military expenditures. Increases and decreases in the level of spending from changes in treaty strength are relative to counterfactual spending at another level of strength (Fearon, 1991). For examples, major powers would spend more on the military if an alliance was weaker, because the treaty would lead to higher spending growth.

Two dimensions shape the association between alliance participation and growth in military spending— major power status and alliance treaty design. Both are necessary to predict when alliance participation increases and decreases military expenditures. Major and non-major powers use alliances for distinct purposes, so they respond differently to greater alliance treaty strength. Alliance treaty design encapsulates commitment strength.

Why focus on treaty design as the key source of treaty strength? Alliances have multiple sources of credibility. DiGiuseppe and Poast (2016) argue that reliable treaty commitments by democratic states will be associated with reduced defense spending. However, democracies are more likely to form weak formal treaties (Mattes, 2012), so it is unclear whether these results are driven by treaty strength or democracy. Alliance treaty design is correlated with other sources of credibility, including capability (Johnson, 2015). By examining treaty design, we can understand the role of these other factors.

Moreover, treaty design is important. Alliance design provides essential information about the likelihood of intervention (Morrow, 2000; Leeds, 2003). Like any other institution, formal alliance promises structure exchange and bargaining among participants (Williamson, 1985; North, 1990; Diermeier and Krehbiel, 2003).

Alliance treaty design is easier to manipulate than other sources of credibility. Policymakers

can adjust formal treaties more easily than they can make other states more democratic, for instance. So understanding the consequences of alliance treaty design provides actionable information for policymakers.

Alliance treaty strength alone cannot explain both higher and lower growth in military spending. Earlier scholarship suggests state size may modify the the association between alliance participation and military spending. Public goods models of alliance participation depend on differences in state size (Olson and Zeckhauser, 1966; Dudley and Montmarquette, 1981; Garfinkel, 2004).

Strong and weak alliances have different impacts on major and non-major powers. The next section describes the concept of alliance treaty strength in more detail. Then I explain how major and non-major powers employ strong and weak alliances to distinct ends.

3.1 Treaty Strength

Alliances promise military support in the event of conflict. Formal treaty commitment is a costly signal of shared interests among members. Treaty promises impose costs on members, making commitments to intervene in conflict more credible (Fearon, 1997; Morrow, 2000). Credible commitment through hands-tying in alliances changes how partners and potential aggressors perceive the likelihood of intervention.

Treaty content provides information to members and potential opponents because some treaties are more costly than others (Leeds, 2003). Public, formal promises of military support expose alliance participants to audience costs from abrogation (Morrow, 2000). Other commitments generate sunk costs for members (Morrow, 2000).

More costly promises increase perceived treaty strength. Attaching no conditions to military support is one source of strength (Benson, 2012). Other sunk cost promises include integrated military command, aid, forming international organizations and establishing bases.

States only form treaties they intend to honor. Therefore, both strong and weak alliances benefit

members. But stronger treaties generate more foreign policy gains through greater credibility.

Additional foreign policy gains in strong treaties are not free. The hands-tying and sunk costs that make the treaty more credible also constrain alliance members (Schelling, 1985). A strong formal treaty reduces members' freedom of action.

Lost freedom of action has different consequences for large and small states. Major powers face foreign entanglement. Non-major powers lose the ability to reduce defense spending.

3.2 Major Powers

States are the actors in this theory. I assume that all states face opportunity costs from military spending. Funds spent on the military could be used for other purposes.

States are divided into major and non-major powers. Both major and non-major powers use alliances and military spending to pursue their foreign policy goals. But major powers have greater size and foreign policy ambition.

Major powers are larger than other states. Increasing state size alters the opportunity costs of military spending. The opportunity costs of military spending are lower in large states.

As the number of taxpayers falls, the marginal cost per taxpayer of an increase in military spending rises (Dudley and Montmarquette, 1981). Increasing military expenditures imposes a greater burden. A larger economy reduces this tax price of defense effort.

Major powers also benefit from economies of scale in defense spending. Producing more defense goods lowers the cost of additional units (Moravcsik, 1991; Alesina and Spolaore, 2006). Thus, major powers have lower marginal costs of military spending.

Major powers have a wider range of foreign policy interests than other states. Broad interests follow from major powers' economic ties, size, and their ability to pursue a wide range of issues. While some states focus on immediate security, others pursue more ambitious foreign policy goals (Fordham, 2011; Markowitz and Fariss, 2017). Major powers have the means and motivation to pursue foreign policy interests beyond securing their homeland.

Due to their extensive interests, major powers employ alliances and military spending to defend partners and gain influence (Morrow, 1991). Shaping the policies of other states and ensuring their alignment benefits major powers. By aiding other states, major powers increase their influence.

Due to lower opportunity costs of military spending, major powers have capacity expand their defense budget. Additional obligations abroad require more military capability. To support alliance commitments, large states often need to increase military spending.

Major powers gain influence by affecting the expected outcome of potential conflicts.[3] Both partners and potential targets of intervention change their behavior in response to potential intervention. How much influence a major power has depends on how likely they are to intervene, and the amount of capability they possess.

Expressed as an abstract equation, influence is a product of the probability of intervention and capability: Influence = Change War Outcome = Probability Intervention $\times$ Capability.

Intervention by a capable state has a large impact on potential war outcomes. Growth in military spending increases a state's capabilities. Additional military spending increases major power influence. A higher perceived likelihood of intervention also builds influence.

Alliances alter the perceived probability of intervention. Due to common interests with a protege, there is a baseline probability of major power intervention even without an alliance. By increasing the probability of intervention through costly commitments, alliances give major powers influence. A greater rise in the perceived probability of intervention increases that influence.

Strong treaties provide more influence through large increases in the perceived probability of intervention. This gives major powers more influence without spending as much on military capability. Greater treaty strength substitutes for military spending as a source of influence.

Although strong alliance treaties reduce the need for more military expenditures, they generate foreign entanglement. Sunk costs commitments like aid, basing, and forming other agreements involve major powers more with their partners. Once implemented, these arrangements are more

[3]Influence has many dimensions. Here, I focus on influence through security.

difficult to reverse. Weaker commitments are more arms-length, as they are limited to promises of military support.

Entanglement is different from entrapment in unwanted conflicts (Snyder, 1997). Entrapment is rare (Beckley, 2015). Major powers can also use their influence in an alliances to restrain partners (Lake, 1996; Fang, Johnson and Leeds, 2014).

For major powers, alliance participation will increase growth in military spending in general. Expanding influence entails growth in military expenditures and alliance participation. Growth will be higher in weak treaties, which provide less influence. As treaty strength increases, growth in military spending from alliance participation will decrease. Major power growth in spending may even be negative under the strongest treaties. Rising treaty strength reduces growth in major power military spending due to alliance participation.

There are several examples of how major powers combine alliance strength and defense spending to generate influence. After World War II, the UK faced acute economic challenges while attempting to influence in the Middle East. "In securing a victorious outcome to the war, the British had severely overstrained themselves" (Kennedy, 1987, pg. 367) The exertions of World War II bankrupted the UK economy, but the UK attempted to maintain an expansive foreign policy (Mayhew, 1950).

Despite their economic constraints, Britain wanted to secure the Suez Canal and oil (Rahman, 1982). Britain did not have the military capability to compete with the US and USSR. Instead, they created strong alliances with Jordan (ATOPID 3125), Libya (ATOPID 3235) and Iraq (ATOPID 3280). In return for basing rights, the UK promised aid, committed to defense consultations, and promised to resolve disputes through the International Court of Justice. Before World War II, London had exerted influence through a preponderance of capability in the region. Afterward World War II, the UK used strong alliance treaties to maintain influence in the Middle East without spending as much on the military.

US foreign policy after World War II also illustrates substitution between treaty strength and

capability as tools of influence. The US balanced between fear of "foreign entanglements" and maintaining influence. The extensive network of alliance commitments to contain the USSR required massive defense outlays (Fordham, 1998). This was especially true because the US made a series of relatively weak formal commitments.

Most US treaties contain few formal promises besides defense against aggression. A noteworthy exception is a 1959 alliance with Iran (ATOPID 3365). The US supplemented its defense commitment with formal promises of military aid, which was unusual. Unlike NATO other treaties with no formal promises of aid, the US did not establish permanent bases in Iran. The aid and defense commitment reinforced US influence in Iran.

Major powers balance influence and entanglement in alliance treaty design. Strong treaties provide more influence, but constrain lost freedom of action. So in some cases, major powers will accept the opportunity costs of higher growth in military spending to retain freedom of action. Non-major powers face a different tradeoff.

3.3 Non-Major Powers

Non-major powers emphasize immediate security. Small states use alliances and military spending to protect their homeland (Morrow, 1991). In doing so, they have greater opportunity costs of military spending.

Small states have a higher marginal cost of military spending. They are less able to access economies of scale in defense. The tax price of spending is also higher than in major powers due to smaller economies.

To offset these opportunity costs, non-major power states will reduce growth in defense spending when possible. Relying on allied capability is one way for non-major powers to maintain their security and lower military expenditures. Alliances can be a force multiplier, but participation does not always lead to lower growth in military spending. Non-major powers must balance reduced defense spending with the risk of losing access to the benefits of alliance participation.

Their emphasis on territorial security makes non-major powers concerned with abandonment (Snyder, 1997). If allies do not honor promises of military support, non-major powers face a significant risk of defeat in war. Potential abandonment produces insecurity.

Stronger alliance commitments reduce the fear of abandonment. Therefore, these treaties are a better source of security. But reduced military spending does not follow.

Though strong treaties provide more security, they also restrict freedom of action. Influence from other alliance members constrains reductions in defense spending. Tying promises of military support to other conditions gives partners more leverage to demand adequate defense effort.

Bargaining leverage for other alliance partners comes from their ability to withhold cooperation on part of the treaty without eliminating promises of military support. If non-major powers fail to maintain adequate defense spending, partners can weaken associated international organizations, reduce aid, or stonewall related negotiations. All these actions impose costs on non-major powers, and reduce the security benefits of the treaty.

Threats to withhold military support are less credible, because partners have interests in providing military aid. Withdrawing from a treaty reduces the security or influence of allied states. Reducing sunk costs commitments maintains the core commitment of the treaty, but reduces side benefits to weak states, inducing them to maintain higher defense effort.

The logic of issue linkages helps explain why small states have less freedom to reduce defense spending in a strong treaty. Issue linkages create situations where both sides benefit in different ways, making treaty formation more likely (Poast, 2012), and the resulting commitments more credible (Poast, 2013). Defection on one issue leads to reduced benefits in another domain. With costly promises in multiple domains, strong treaties give states the ability to employ issue linkages while bargaining over alliance contributions.

Under a weak treaty, non-major powers still gain security while retaining the freedom to reduce defense spending. In a weaker treaty, military support is the only costly commitment. So partners can only threaten to withhold military support because smaller states are not providing for their

own defense, but that is not a credible threat. Withdrawing military support eliminates the benefits of the treaty for all partners. Weaker treaties give non-major powers the ability to reduce growth in military spending and rely on allied capability.

NATO is an excellent example of these dynamics. The NATO treaty makes few costly promises besides the core defensive commitment in Article 5. The US has threatened to abandon NATO in response to European "free-riding," but those threats were not credible. US interests in containing the USSR trumped irritation with allied free-riding. But without other formal treaty commitments to influence NATO members, the US had few ways besides public statements to check allied desires to reduce growth in military spending.

Thus, for non-major powers growth in defense spending will increase as alliance treaty strength rises. Weak commitments still give security, along with the freedom to reduce the opportunity costs of defense expenditures. Strong treaties give allies more leverage to press for adequate defense spending.

For non-major powers, the impact of alliance participation on growth in military spending will be negative in weak treaties. As treaty strength increases, this negative association will diminish. High values of treaty strength may even increase growth in military expenditures. Greater treaty strength attenuates reduced growth in military spending for non-major powers.

Their relative emphasis on influence or security lead major and non-major powers to respond differently to greater alliance treaty strength. Strong treaties will reduce growth in major power military spending, relative to weak treaties. Conversely, strong treaties will increase growth in non-major power military spending.

3.4 Predictions

For major powers, strong alliances substitute for military spending as a tool of influence. Connecting military support to other promises gives large states more influence. As a result, increasing alliance treaty strength will reduce growth in military spending in major powers.

	Strong Treaty	Weak Treaty
Major Power	(1) Decreased Growth Spending	(2) Increased Growth Spending
Minor Power	(3) Increased Growth Spending	(4) Decreased Growth Spending

Table 2: Summary of Argument

Under a weak treaty, large states have less formal influence. But the treaty still increases their foreign policy reach and obligations. Additional foreign policy obligations require growth in military spending (Diehl, 1994). To maintain their influence, major powers will increase military expenditures given a weaker treaty.

Growth in military spending will be positively correlated with treaty strength for non-major powers. Strong treaties provide more security by adding other costly promises. The promises also reduce the freedom of action for small states to reduce military spending.

Given a weak treaty, non-major powers still gain security without losing as much freedom of action. Allied states have less formal leverage to check the incentives of non-major power partners to reduce spending under a weaker treaty. As a result, they are free to reduce military spending. Strong treaties provide more security, with less freedom for small states to reduce spending. Therefore, growth in military spending is increasing in treaty strength.

Major power status and treaty strength modify the association between alliance participation and growth in military expenditures. I summarize the two dimensions of the argument in Table 2. Each cell corresponds to a combination of major power status and treaty strength.

Table 2 can be distilled into two distinct hypotheses. The first prediction addresses growth in military spending for large states as treaty strength increases. If weak treaties lead large states to increase spending, and treaty strength substitutes for capability, then growth in major power military expenditures will decrease as treaty strength increases.

HYPOTHESIS 1: As alliance treaty strength increases, growth in major power military spending will decrease.

The second prediction deals with increasing treaty strength in non-major powers. If non-major powers reduce military spending in weak treaties and rising treaty strength constrains their ability to reduce expenditures, then growth in non-major power military spending will increase as treaty strength increases.

> HYPOTHESIS 2: As alliance treaty strength increases, growth in non-major power military spending will increase.

Hypotheses 1 and 2 compare strong and weak treaties, so the the research design must compare treaties and measure alliance treaty strength. I use a measurement model to operationalize treaty strength and link alliances with state military spending using a multilevel model. The next section describes the research design in more detail.

4 Research Design

This research design makes two contributions. First, I develop a latent measure of alliance treaty strength. Then I employ that measure in a multilevel model, connecting alliance-level variation with state-level outcomes. To examine differences between major and non-major powers, I estimate the multilevel model in separate samples of major and non-major powers from 1816 to 2007. The next section describes my measure of alliance treaty strength.

4.1 Measuring Alliance Treaty Strength

Observed alliance promises reflect the underlying strength of the treaty. A stronger alliance contains more costly promises. Therefore, I use observed alliance characteristics to infer treaty strength.

Treaty strength and credibility depends on the costs of abrogation and other costly promises in the pact (Leeds, 2003). The costs of abrogation are tied to core commitments of defensive or

offensive military support, and conditions on support.[4] Sunk costs promises in alliances include integrated military command, forming international organizations, basing rights, promises to make other agreements, and economic or military aid.

Conceptualizing observed treaty conditions as indicators of underlying strength permits several measures of treaty strength. One is choosing a crucial indicator of treaty strength, such as unconditional military support, and coding measures of its presence. Treaty strength is multidimensional, however, so this measure is too coarse.

Another option is constructing an additive index of treaty strength. Treaties with more costly promises would have higher index values and greater strength. This assumes each indicator is equally important, which is unlikely. There are less restrictive ways to construct a measure.

Latent variable modeling is the best way to measure alliance treaty strength. It does not reduce strength to one alliance characteristic, or apply arbitrary weights to an index. Instead, latent variable models use observed treaty characteristics to infer an unobserved concept.

Measurement models have a rich history in political science (Clinton, Jackman and Rivers, 2004; Treier and Jackman, 2008; Fariss, 2014). Benson and Clinton (2016) use the mixed factor analysis model of Quinn (2004) to measure alliance scope, depth and capability. Like Benson and Clinton, I employ a latent variable model, but with another concept and estimator.

I use the Bayesian Gaussian Copula Factor Model of Murray et al. (2013) to measure alliance treaty strength. Murray et al's model improves on mixed factor analysis for continuous, ordinal, and binary observed data by relaxing distributional assumptions. With discrete observed variables and non-Gaussian latent variables, the dependence among the latent variables and their marginal distributions are both influenced by the latent variables. Their model encodes the dependence structure of multivariate latent data using a copula,[5] and expresses the latent variables and factor loadings as a series of latent normal variables. This semiparametric approach breaks the dependence

[4]Some alliances promise only neutrality, consultation, or non-aggression, rather than military support.

[5]Copulas are distribution function on $[0,1]^p$ where each univariate marginal distribution is uniform on $[0,1]$. This function encodes the dependence structure of a multivariate distribution.

between the latent factors and marginal distributions.

Beyond the semiparametric component, this measurement model employs a general factor analytic approach. Factor analysis estimates the association between observed variables and some latent factor. Each observed variable has a factor loading— the association between the observed variable and the latent variable. Like standardized regression coefficients, factor loadings range from -1 to 1, so observed variables are positively or negatively correlated with the latent variable.

For each observation, a linear combination of observed alliance characteristics predicts latent treaty strength, like a regression with an unobserved outcome. I took alliance characteristics for all 745 alliances in the alliance-level ATOP data (Leeds et al., 2002). Indicators of treaty strength include promises of defensive support, offensive support, neutrality, consultation, non-aggression, unconditional military support, military aid, economic aid, bases, international organization formation, integrated military command, and promises to form new agreements in multiple issue areas. My argument suggests there is one latent factor underlying variation in these indicators.

The Bayesian Gaussian copula factor model generates posterior distributions for the factor loadings and the latent factor. I used Parameter expanded Gibbs sampling, the default generalized double Pareto (GDP) prior, 10,000 burn-in iterations of the MCMC chain, and 20,000 samples thinned every 20 observations to ensure convergence. Because treaty strength is the main quantity of interest for this paper, I focus on the posterior distributions of the latent factor.

Each alliance has a unique posterior distribution of the latent strength measure. The mean of that distribution measures expected treaty strength. Figure 1 describes the latent measure for all ATOP alliances from 1815 to 2016. The empirical analysis includes only treaties that promise military support, but measuring all alliances means the model estimates the contribution of defensive and offensive conditions to treaty strength.

As the top panel of Figure 1 shows, most alliances make weak formal promises. 456 alliances have no promises of offensive or defensive support, reducing the costs of abrogation. Almost all the remaining 289 treaties have positive mean strength.

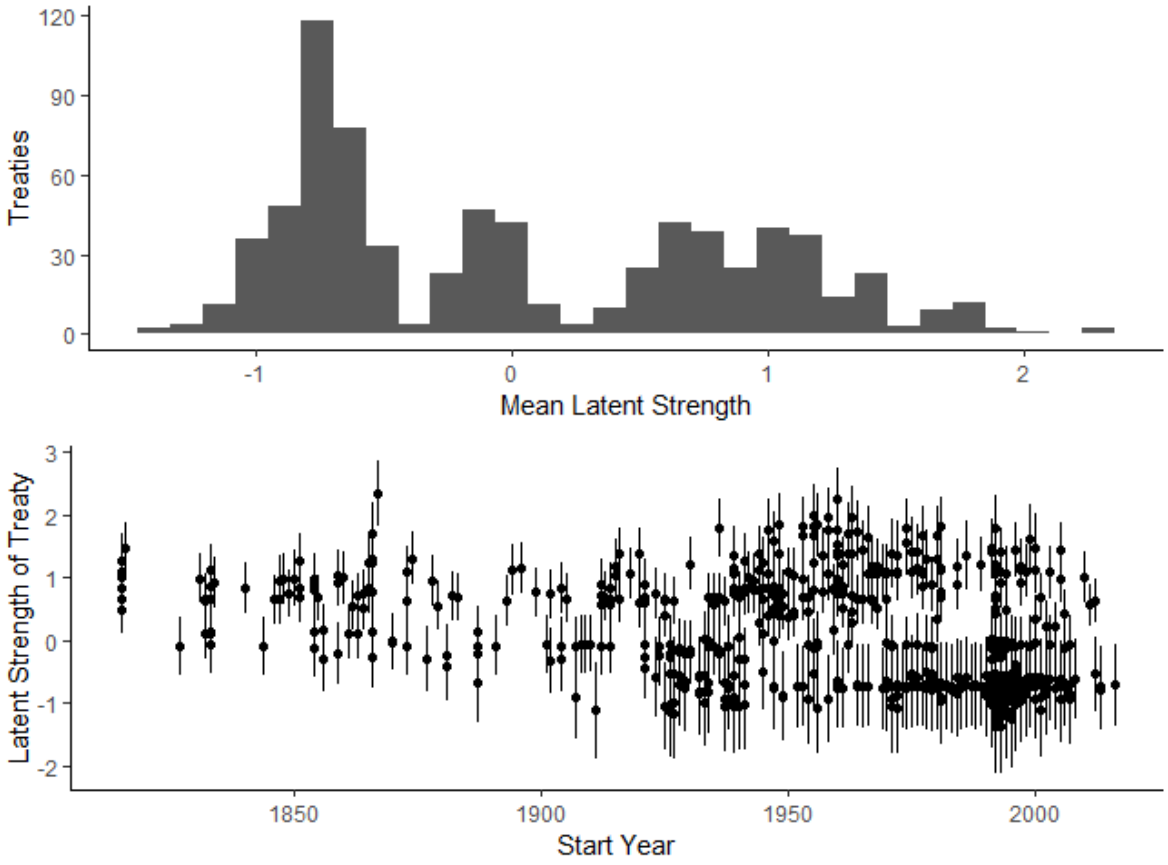

Figure 1: Summary of latent measure of alliance treaty strength for 745 alliances from 1816 to 2016. The top panel is a histogram of the expected of alliance treaty strength. The bottom panel plots mean treaty strength (points) and the standard deviation (error bars) against the start year of the treaty.

The bottom panel of Figure 1 plots the posterior means and uncertainty in those estimates against the start year of the treaty. Even after accounting for posterior uncertainty, it is possible to distinguish between many strong and weak treaties. Institutionally weak treaties proliferated in the 20th century, with many non-aggression and consultation pacts.

The values of the latent strength measure are not intrinsically informative. Differences between treaties on the latent strength scale are meaningful, however. The mean of treaty strength is 0.01, and the median is -0.10. The median treaty is a 1938 consultation pact between France and Czechoslovakia (ATOPID 2120).

The weakest treaty is a neutrality and non-aggression treaty between Georgia and Kazakhstan (ATOPID 4476). An almost equally weak treaty between between Ukraine and India (ATOPID 4188) scores -1.36 on the latent measure. The three strongest treaties are an 1867 alliance between Prussia and Hesse (ATOPID 1290), a 1955 treaty between Greece and Turkey governing relations in Cyprus and the United Arab Republic (ATOPID 3300). NATO scores 0.75, placing it in the upper edge of the third quartile of treaty strength.

These examples show some face, concept, and discriminant validity of the latent measure. The UAR is a stronger commitment than non-aggression between India and Ukraine, for example. The weakest treaties made few costly promises, matching my conceptualization of treaty strength. This measure makes a clear distinction between weak and strong commitments. I now describe how and why I use a multilevel model to estimate the association between this measure of treaty strength and alliance members' military spending.

4.2 Multilevel Model

Multilevel modeling incorporates elements of the specific and general research designs in previous research. Specific studies focus on responses to allied spending in particular treaties, while general studies in panel data rely on coarse aggregates of alliance participation. In this model, I estimate the specific impact of each alliance on member's military spending and the general

association between treaty strength and military expenditures. To overcome common statistical challenges, I fit this model using Bayesian estimation in STAN (Carpenter et al., 2016).[6]

The multilevel model is more complex than traditional approaches. But added complexity has several benefits. Multilevel modeling connects the argument and research design. My predictions compare strong and weak treaties and an alliance level regression in this multilevel model contains a corresponding coefficient. Relying on a state-level proxy for alliance strength generates different comparisons and changes the variation in a key independent variable which may produce misleading inferences (McElreath, 2016).

Multilevel modeling matches the structure of the data. Alliances and states are separate levels of analysis. Connecting the alliance and state level of analysis allows us to infer how alliance variation impacts states' military expenditures.

Added complexity facilitates comparisons between alliances. An alliance-level regression estimates how multiple alliance characteristics are correlated with alliance strength and military spending. Partial pooling produces reasonable estimates of the impact of each alliance on members' military spending. Comparing patterns in these alliance-specific coefficients provides additional evidence to examine Hypotheses 1 and 2 as well as the importance of treaty strength.

This multilevel model connects two distinct regressions. The base is a state-level regression, which is similar to a random effects panel data regression. A second alliance-level regression predicts parameters in the state-level regression, like an interaction.

The state-level regression starts with a distribution for the outcome:

$$y \sim student_t(\mu, \nu, \sigma) \tag{2}$$

y is growth in military spending. I model growth in spending using a t-distribution with degrees of freedom ν to address outliers. σ is analogous to the error term in a frequentist regression— this

[6]See the appendix for details of the weakly informative prior distributions and evidence of convergence.

captures unexplained variation in spending growth. μ, the mean of the outcome, depends on several covariates.

$$\mu = \alpha + \alpha^{st} + \alpha^{yr} + \mathbf{W}\gamma + \mathbf{Z}\lambda \tag{3}$$

Growth in spending is a function of an overall intercept α, state and year varying intercepts α^{st} and α^{yr} and a matrix of state-level control variables $\mathbf{W}$. These components are a standard random effects model. The $\mathbf{Z}\lambda$ term is the innovation adding alliance participation.

$\mathbf{Z}$ is a matrix of state participation in alliances. Columns correspond to alliances, and rows to state-year observations. If a state is not part of an alliance, the corresponding cell of the matrix is zero. If a state is part of an alliance in a given year, the corresponding cell is the log of total allied military spending.

I use total allied spending in the alliance participation matrix because more capable alliances provide extra benefits. Increasing allied capability makes promises of military support more valuable (Johnson, Leeds and Wu, 2015). Treaty design then modifies the impact of allied capability. This measure also compares states inside and outside the treaty— allied spending only applies to treaty members. So estimates of λ also incorporate a change from no allied capability to some.

Because the non-zero elements of Z are allied spending, the λ parameters capture alliance members' responsiveness to greater allied capability. Each alliance has a unique λ, which I give a common distribution. The shared distribution assumes alliances are similar but different in how they impact growth in military spending.

The second part of the multilevel model uses alliance characteristics to predict how allied spending is associated with growth in military spending. The λ parameters are the dependent variable in an alliance-level regression which includes treaty strength. Therefore, I focus interpretation on this alliance-level regression, where:

$$\lambda \sim N(\theta, \sigma_{all}) \tag{4}$$

and

$$\theta = \alpha_{all} + \beta_1 \text{Treaty Strength} + \mathbf{X}\beta \tag{5}$$

In this alliance-level regression, $\mathbf{X}$ is a matrix of alliance-level control variables and α_{all} is the constant. Adding σ_{all} means predictions of λ are not deterministic— the alliance level regression contains an error term. Coefficients in the alliance-level regression are like marginal effects in an interaction. A change in treaty strength modifies λ, which alters growth in military spending. Hypothesis 1 predicts β_1 will be negative among major powers, and Hypothesis 2 expects β_1 will be positive for non-major powers.

Consider one observation as an example of how the model works. Growth in Argentina's military spending in 1955 depends on Argentina's economic growth, political regime, conflict participation, and rival military spending. Argentine participation in the Rio Pact and OAS also changes growth in spending through allied capability.

$$\begin{aligned}\text{Argentina 1955} = \text{Overall mean} + \text{Argentine Intercept} + \text{1955 Intercept} + \text{Argentine Characteristics} \\ + \lambda_{OAS} * \text{OAS Expenditure} + \lambda_{Rio} * \text{Rio Pact Expenditure}\end{aligned} \tag{6}$$

λ_{OAS} and λ_{Rio} are modified by the alliance level regression. The institutional design and membership of these treaties alter the λ parameter. Alliances Argentina did not participate in have no impact on growth in military spending.

The multilevel model is interactive, which is appropriate for my conditional argument. Alliance characteristics modify the impact of allied spending on growth in state military spending. I now describe the sample and covariates in the analysis.

4.3 Sample and Covariates

I estimate this model on two samples of states from 1816 to 2007. Alliance participation data comes from the ATOP project (Leeds et al., 2002). I focus on participation in defensive and offensive treaties, because prior studies of alliances and military spending emphasize these treaties.

My argument suggests that major and non-major powers use alliances for different purposes. Major powers focus on influence, non-major powers emphasize immediate territorial security. Therefore, the entire data-generating process connecting alliance participation and military spending is different for major and non-major powers. To capture these differences, I estimate the model in separate samples- one sample of major powers, the other of non-major powers. I employ the classification of major power status from the Correlates of War Project.

The non-major power sample contains 8,668 observations in the state-level regression, and 192 alliances. There are 930 major power observations and 148 alliances. Though the major power sample is smaller and has fewer states, Bayesian estimation and partial pooling should give plausible estimates (Stegmueller, 2013).

The dependent variable is growth in military spending. I calculated growth in spending using the Correlates of War Project's measure of military spending (Singer, 1988). Growth in spending is equal to changes in spending as a share of the previous year's military spending, so changes are relative to previous levels of spending.

In the state-level regression, I control for several correlates of alliance participation and military spending. State-level covariates include GDP growth (Bolt et al., 2018), regime type, international war (Reiter, Stam and Horowitz, 2016), civil war participation (Sarkees and Wayman, 2010), annual MIDs (Gibler, Miller and Little, 2016), rival military spending (Thompson and Dreyer, 2012) and a dummy for Cold War years. I include growth in GDP instead of levels of GDP because GDP levels are non-stationary, and economic growth shapes the opportunity costs of military spending (Kimball, 2010; Zielinski, Fordham and Schilde, 2017).

The alliance-level regression contains the mean of the latent treaty strength— the key inde-

pendent variable. Other alliance level variables include the number of members and share of democracies in a treaty at time of formation (Chiba, Johnson and Leeds, 2015). I also control for superpower membership— whether the US or USSR participated in a treaty during the Cold War. Two dummy indicators of wartime alliances and asymmetric obligations (Leeds et al., 2002) complete the alliance-level regression specification.

Democratic membership is associated with limited obligations (Chiba, Johnson and Leeds, 2015) and lower military spending (DiGiuseppe and Poast, 2016) in alliances, making it a particularly important alliance-level control. State and alliance-level controls for threat and conflict participation capture situations where states are more likely to seek allies. The next section describes the results.

5 Results

Results are based on 2,000 total samples from four chains, with 1,000 warm-up iterations. To facilitate model fitting, I employed a non-centered parameterization of the varying intercepts and a sparse matrix representation of $\mathbf{Z}$. Standard convergence diagnostics indicate the chains adequately explored the posterior density.[7]

Because I use Bayesian modeling to estimate the association between treaty strength and growth in military spending, there are no conventional indicators of statistical significance. Instead, each coefficient has a posterior distribution— the likely values of the coefficient conditional on the prior and observed data. Thus I calculate the negative and positive posterior probability for the two treaty strength coefficients to assess Hypotheses 1 and 2.

Figure 2 plots the full posterior density of the treaty strength coefficients in the major and minor power samples.[8] 96% of the posterior mass for major powers is negative. 94% of the posterior mass for minor powers is positive. There is little overlap between these two posteriors—

[7] See the appendix for more details on convergence.

[8] The smaller sample for major powers produces more variance in all the coefficient estimates.

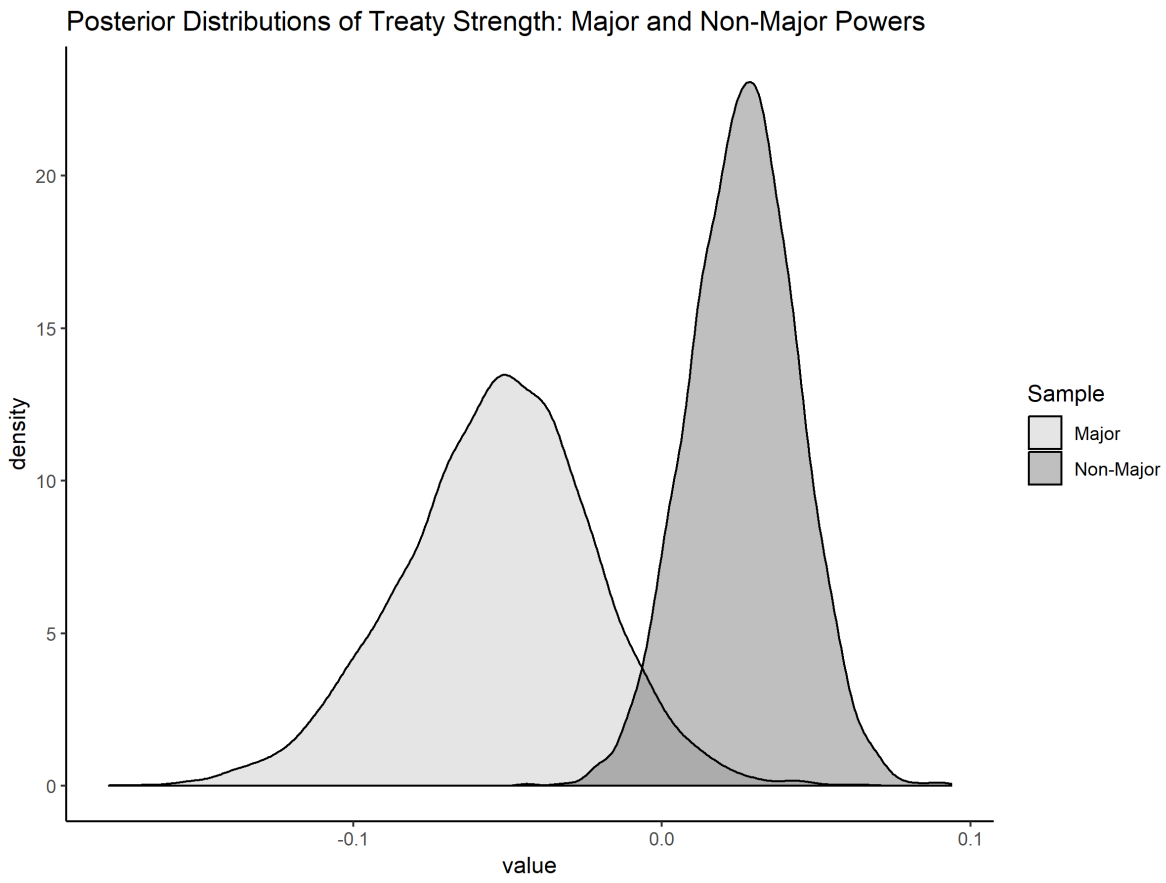

Figure 2: Posterior density of treaty strength coefficient in major and non-major power samples, 1816 to 2007. 96% of the major power posterior mass is negative. 94% of the non-major power posterior mass is positive.

there is a 99% chance that the association between treaty strength and military spending is larger for minor powers than major powers.

These two coefficient estimates match the predictions of Hypotheses 1 and 2. For major powers, there is a 96% chance increasing treaty strength is associated with lower growth in military spending. There is a 94% chance greater treaty strength is associated with higher growth in military spending for non-major powers.

How substantively important is treaty strength? Among major powers, the mean of the treaty strength coefficient is -0.05, and median growth in military expenditures is 0.04.[9] So a one-unit increase in treaty strength nearly offsets the typical annual growth in military spending.

For non-major powers, the mean of the treaty strength coefficient is 0.03, and median growth in military expenditures is 0.06. Greater treaty strength increases growth in minor power military expenditures by about half of typical growth. Higher treaty strength has a large substantive effect, relative to the scale of the data.

We can also examine how much changing treaty strength influences on the overall association between changes in allied spending and growth in defense spending. Each λ measures the aggregate impact of changes in allied capability for a treaty. If greater treaty strength has a large influence on the λ parameters, there will be a clear trend in the value of λ across the range of alliance treaty strength. We should observe a negative trend in the expected value of λ as treaty strength increases in major power alliances. There will be a positive trend in λ for non-major power alliances.

Figure 3 plots the expected value of λ against treaty strength in the two samples. In the major power sample, there is a negative trend in the scatter plot. For non-major powers, the trend is positive. In both samples, the correlation between mean λ and treaty strength is statistically significant.

[9]The median is a better summary of the dependent variable because large positive and negative outliers influence the mean.

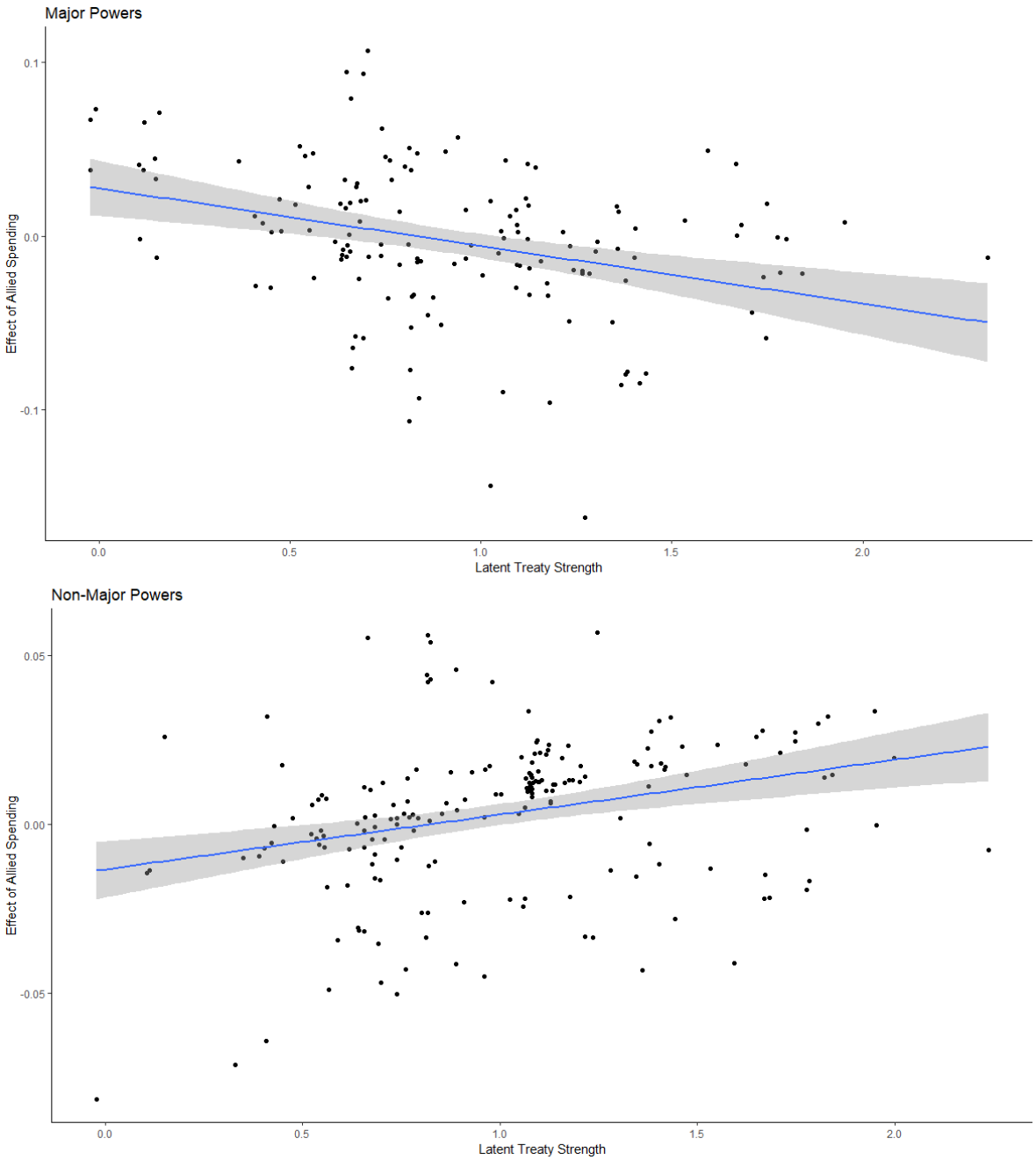

Figure 3: Scatter plots of trends in mean λ parameters and treaty strength. λ is the total impact of alliance participation on growth in military spending. The top panel is major powers, where this is a negative trend between λ and treaty strength. In the bottom panel the same trend is positive for non-major powers. Trend lines estimated using linear regression.

These trends match the predictions in Table 2. Weaker treaties tend to increase growth in defense spending for major powers, but that positive correlation falls as treaty strength increases. In non-major powers, the trend starts negative and becomes more positive as treaty strength rises. Other alliance characteristics ensure trends in strength and the aggregate impact of a treaty are probabilistic— not all treaties conform to the expectations of decreasing or increasing growth in spending.

Because λ captures the total impact of an alliance, this pattern suggests that increasing alliance strength has an important role. Even after accounting for other alliance characteristics, alliance strength drives the overall effect of allied spending down for major powers, and up for non-major powers.

6 Discussion

The results conform to expectations of Hypotheses 1 and 2. Increasing treaty strength is positively associated with growth in military spending in non-major powers. Greater treaty strength is associated with lower growth in military spending for major powers, who use treaty strength and military capability as substitutes while seeking influence.

These results contribute to the debate over whether alliance participation increases or decreases military spending. Dissension between the force multiplier and foreign entanglement views of alliances is based on competing claims about the purposes of alliances. These mutually exclusive assertions are inaccurate.

My findings and argument suggest claims alliance participation only increases or decreases military spending are inappropriate. Instead, the association between alliance participation and growth in military spending depends on alliance member size and treaty strength. Alliance participation has heterogeneous effects because major powers and non-major powers employ treaties for different purposes.

The force multiplier perspective applies best to security-seeking non-major powers. But these states cannot reduce growth in military spending in all alliances, because strong treaties constrain their freedom of action. Alliances are a foreign entanglement for major powers. But additional entanglement in a strong treaty provides more influence, attenuating the positive correlation between alliance participation and growth in military spending.

Comparing my results to prior evidence requires renewed attention to specific and general research designs. Some general studies compare states in a particular kind of alliances to those outside the treaty. Most specific studies responsiveness to allied military spending.

How do my results fit with other evidence on alliance participation and military spending? My key coefficient estimates compare strong and weak treaties, not states with a treaty to those without. However those estimates are like marginal effects- increasing treaty strength alters the effect of alliance participation.

λ measures the impact of increasing allied spending *for states in a treaty*. These parameters capture the impact of alliance participation only for treaty members. Therefore, a comparison between treaty members and non-members is included in the statistical model. Greater treaty strength decreases the association between alliance participation and growth in military expenditures for major powers, and increases it for non-major powers.

This paper has several limitations. The argument does not address the domestic political economy of military spending. My argument reduces domestic politics to an assumption that military spending has opportunity costs, which are decreasing in state size.

For the research design, measures of military spending contain substantial measurement error. There is also a great deal of missing data in the 1816–2007 time frame of this study. I plan to check the robustness of my results to these issues by adding measurement error to the outcome and imputing missing data.

The multilevel model only incorporates time-invariant alliance characteristics, save for changing capabilities in the membership matrix. So I measure share of democratic members and the

number of members at time of formation. Allowing time-varying alliance characteristics might improve the statistical model, but would require altering the model structure.

Strategic alliance design is the last major weakness of the research design. Non-random selection into different kinds of alliances might produce systematic differences between members that are not controlled for in my statistical model. I attempted to control for correlates of alliance treaty strength, especially democracy, but oversights are possible.

7 Conclusion

This paper presented an argument and empirical evidence linking alliance participation and military expenditures. I explain when alliance participation is associated more or less growth in military spending, addressing a debate between the force entanglement and foreign entanglement views of alliances. For major powers, greater treaty strength leads to lower growth in spending. Non-major power growth in spending is positively correlated with alliance treaty strength. I provide evidence for these predictions using a new measure of alliance treaty strength and a multilevel model.

Growing military spending growth has distributional consequences in the domestic economy. So the design of international alliances alters the domestic political economy of member states. Non-major powers confront the opportunity costs of additional defense spending in strong treaties. Major powers can use strong treaties to reduce to domestic costs of their foreign policy ambitions.

There are several next steps for research on alliances and military expenditures. One is extending the argument to other alliance characteristics. If major and non-major powers employ alliances for different ends, then other alliance characteristics may have different impacts on military spending. Large and small states should use wartime and asymmetric treaties differently, for instance.

Another task for future research is making more detailed comparisons of the λ parameters.

Each λ captures the aggregate impact of alliance participation for individual treaties. As such, these parameters are a novel measurement, and additional evidence of when alliance participation increases or decreases military spending.

The multilevel model estimates alone do not establish causality (Seawright, 2016). But the λ parameters can guide case selection for a process-tracing analysis to corroborate the regression results. One possible design is selecting the five largest and smallest λ values for major and minor powers, and determining whether the connection between alliance participation and military expenditures matches the theoretical process.

The research design in this paper applies to other international relations questions. If scholars are interested in a class of international organizations and states are members in multiple organizations, the multilevel model incorporates multiple membership. For example, international political economy scholars could apply this model to trade agreements. Studies of international law could examine the impact of membership in different conventions and international organizations on human rights.

The argument and evidence suggests that major and non-major powers each face a tradeoff in alliance treaty design. Major powers tradeoff between entanglement and greater influence in strong treaties. Non-major powers sacrifice freedom of action for greater security as treaty strength rises.

These twin tradeoffs have important consequences for policy debates. The United States has a long history of decrying "free-riding" by allies who provide too little for their own defense (Lanoszka, 2015). But allies may be able to free-ride because the US prefers to form relatively weak alliance commitments. "Entangling alliances" can provide greater influence to curb falling allied defense spending.

Therefore, growing institutionalization of NATO, including the agreement for all allies to spend at least 2% of GDP on defense, may be effective. However, treating alliances between major and non-major powers as a public good and decrying low defense effort as free riding, is inappropriate. Asymmetric alliances produce different goods for different members. Major powers seek

influence, while non-major powers secure their homeland.

The US could use stronger formal commitments as a substitute for greater defense effort in reassuring allies. The danger is that making stronger commitments could create a situation where obligations exceed capabilities (Kennedy, 1987). Emboldening junior partners with a strong treaty might have deterrent value (Benson, Meirowitz and Ramsay, 2014), or increase the risk of conflict (Benson, 2012).

The connection between alliance participation and military expenditures depends on state size and the strength of the treaty. Alliance participation does not exclusively increase or decrease military spending. Both the force multiplier and foreign entanglement views of alliance participation are correct, each in different circumstances.

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