

Alliance Participation, Treaty Depth, and Military Spending

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Abstract

How does alliance participation affect military spending? Some argue that joining an alliance increases defense expenditures, while others contend that it produces spending cuts. I argue that how alliance participation affects military expenditures depends on the depth of military cooperation in the treaty. Alliance depth reveals a tradeoff between reassurance and free-riding, as security-seeking non-major powers decrease military spending in deeper alliances but increase it in shallow alliances. I test the argument by creating a measure of alliance treaty depth and employing it in a multilevel model. The research design generates new empirical evidence linking alliance participation and percentage changes in state military spending from 1816 to 2007. I find that greater alliance depth reduces the impact of alliance participation on non-major power military spending. This result helps scholars and policymakers better understand a central question about alliance politics that has been debated in scholarship for decades.

1 Introduction

Scholars of international relations have long acknowledged that there are two ways for states to increase their security. They can invest in indigenous military capability or form alliances (Mor-

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genthau, 1948; Altfield, 1984; Morrow, 1993). Because both policies provide security, broadly defined, alliance participation should change how states invest in military capability. But exactly how alliances influence military spending remains unclear.

Existing scholarship produces contradictory predictions and evidence on the question of alliance participation and military spending. One view expects alliance participation will reduce military spending (Morrow, 1993; Conybeare, 1994). The other predicts alliance participants will spend more on defense (Diehl, 1994; Morgan and Palmer, 2006). This paper addresses the divide by explaining when alliance participation leads to more or less defense spending. In doing so, it helps clarify a longstanding debate about alliance politics.

Debate between the two perspectives largely ignores heterogeneity among alliances,¹ which is essential to alliance politics scholarship (Morrow, 1991; Leeds, 2003*b*; Leeds and Anac, 2005; Fordham, 2010; Mattes, 2012; Benson, 2012; Poast, 2013; Johnson, Leeds and Wu, 2015). Given differences between treaties and states, alliance participation could plausibly increase or decrease defense expenditures. I emphasize the role of treaty depth to explain how alliance treaty participation impacts military spending.

Deep alliances formalize extensive defense cooperation between members, which reassures allies and facilitates policy coordination. Rather than make arms-length commitments of military support, these treaties promise military aid, create formal institutions and obligate members to coordinate defense policy. For example, a 1963 alliance between Jordan and Iraq commits to military support as well as military aid, bases and institutions to manage defense coordination.

Greater treaty depth increases free-riding by non-major power alliance participants. I focus on non-major powers because these states are more inclined to free-ride: they emphasize immediate security and have high opportunity costs of military spending. Reassurance and credibility from a deep alliance, as well as efficiency gains, allows non-major powers to reduce military spending. As a result, participation in deep alliances reduces non-major power military spending. Joining a

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

shallow alliances is more likely to increase military spending because allies have more leverage over free-riding and members must hedge against the risk of abandonment.

I employ a novel research design to test my argument. First, I develop a latent measure of alliance treaty depth. I then incorporate that measure into a multilevel model which estimates how alliance treaty characteristics modify the impact of alliance participation on percentage changes in military spending. Multilevel modeling matches my conditional argument and generates inferences about individual alliances. I fit the model on a sample of non-major power states from 1816 to 2007. I find that increasing treaty depth reduces the impact of alliance participation on percentage changes in non-major power military spending. Although increasing treaty depth reassures allied states, it increases free-riding.

The trade off between reassurance and free-riding illuminates a salient debate in US foreign policy about the costs and benefits of alliances. Advocates of deep engagement (Brooks, Ikenberry and Wohlforth, 2013) and restraint (Posen, 2014) in grand strategy have different views of alliances. Advocates of restraint argue that the United States should withdraw from many alliances, because allies spend too little on defense, which then increases US defense spending (Preble, 2009). Proponents of continued deep engagement argue that the benefits of alliances exceed the costs, and the extent of allied free-riding is overstated (Brands and Feaver, 2017). Debates about how to respond to low defense spending by US allies should consider that reassurance may increase the extent of free-riding.

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

2 Do Alliances Increase or Decrease Military Spending?

Scholarship on alliance participation and military spending is divided between two views. Each predicts a different average or unconditional effect of alliance participation by emphasizing one aspect of alliance politics. I first address the substitution and public goods logics connecting alliance participation with reduced defense spending.

2.1 Why Alliances Could Decrease Military Spending

These arguments start with the premise that alliances and military spending both provide security. The first such model treats security from an alliance as a public good. Olson and Zeckhauser argue that alliances are subject to a collective action problem (Olson and Zeckhauser, 1966). Because alliance security is neither rivalrous nor excludable, members contribute inadequate resources to collective defense. Alliance members can “free-ride” and smaller states exploit larger partners. Lower spending allows alliance members to consume more non-defense goods, but the alliance provides suboptimal security.²

Another argument that predicts reduced defense spending focuses on substitution between foreign policy instruments. Substitution arguments recognize that states employ one policy in place of the other (Most and Starr, 1989). Alliances provide security without requiring additional military spending (Morrow, 1993; Conybeare, 1994). Given extra security, states rely on their allies and reallocate military spending to other goods.

Both the substitution and public goods models expect that alliance participation reduces military spending due to opportunity costs of military expenditures. States want to rely on their allies for security because spending more on the military leaves fewer resources for other goods (Fordham, 1998; Fearon, 2018). On the other hand, a contradictory perspective asserts that alliance participation increases military expenditures.

²Sandler and Forbes (1980), Oneal (1990) and Sandler and Hartley (2001) all modify the public goods logic while relying on Olson and Zeckhauser’s core intuition.

2.2 Why Alliances Could Increase Military Spending

Several arguments predict higher military spending by alliance members. All share an intuition that states increase military spending to support their alliance commitments. In these arguments, investing in the military secures foreign policy gains from alliance participation.

Diehl argues that alliances increase foreign policy obligations, necessitating extra military spending (Diehl, 1994). Because alliances expand what a state can achieve in international relations, states increase military spending to pursue other foreign policy goals Morgan and Palmer (2006). For example, buffer states use conscription to make themselves a more attractive alliance partner (Horowitz, Poast and Stam, 2017). Others assert that alliances generate cooperation, leading to higher defense spending (Palmer, 1990; Quiroz Flores, 2011). These predictions of a positive correlation between alliance participation and military spending contradict expectations of lower military spending by alliance members.³

2.3 Mixed Evidence

Debate between the contradictory views of alliances could be settled by a consistent set of average effects, but mixed results reinforce the theoretical division. Some studies find a positive association between alliance participation and military spending. Others find a negative relationship.⁴

General studies of military spending and alliances compare many states through dummy indicators of alliance participation, which collapse alliances into a state-level measure. This design compares states with an alliance to those without. Table 1 summarizes previous results from general models of alliance participation and military spending. There is one negative, three positive

³Senese and Vasquez (2008) argue that military spending and alliances are part of a conflict spiral of simultaneous growth in military expenditures and alliance participation. This argument suggests that any correlation between alliances and military spending is driven by conflict behavior, not treaty participation.

⁴Because tests of the public goods model use military spending as a share of GDP as the their outcome of interest, I ignore most of those results.

and two null estimates of the correlation between alliance participation and spending.

	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	

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

Unlike general studies, specific research designs examine individual treaties and estimate responses to military spending of key allies. Most evidence of reduced military spending by alliance members comes from alliance-specific research designs (Barnett and Levy, 1991; Morrow, 1993; Sorokin, 1994; Plümper and Neumayer, 2015; George and Sandler, 2017). Other specific studies find increased spending by alliance members, however (Conybeare and Sandler, 1990; Chen, Feng and Masroori, 1996).

The mixed empirical results reflect a theoretical problem. Both perspectives make unconditional claims about the average effect of alliance participation on military spending. With one exception (DiGiuseppe and Poast, 2016), scholarship on alliance participation and military spending ignores differences between alliances. Treaty obligations vary widely across alliances (Leeds et al., 2002), which leads to heterogeneous effects. Conflict (Leeds, 2003*b*; Benson, 2012) and trade (Long, 2003; Long and Leeds, 2006) are two domains where alliance design shapes the consequences of treaty participation. Building on this work, I focus on one key difference between alliances that can help us understand their heterogeneous effects on military spending: the depth of cooperation in the treaty.

3 Argument

Deep military cooperation in an alliance treaty reduces the impact of alliance participation on non-major power military spending. Treaty depth increases non-major powers' tendency to free-ride through reassurance and efficiency gains. Given greater treaty credibility, non-major powers have the freedom to reduce defense spending. Efficiency gains also allow non-major powers to depend on their allies for crucial military capabilities. Therefore, deep alliances have a lower impact on percentage changes in non-major power military spending than shallow ones.

I start the argument by describing problems of opportunism and enforcement in alliances. Then I describe the role of deep formal military cooperation. Last, I show how alliance depth increases the extent of non-major power free-riding.

3.1 Opportunism in Alliances

Alliances are a form of international cooperation. By promising to aid one another in war, states make a credible commitment of intervention (Fearon, 1997; Morrow, 2000). Allied support helps members achieve crucial foreign policy goals like deterrence or success in war (Walt, 1990; Snyder, 1997).

Like all cooperation, alliances must address opportunism, or “behavior with guile” (Williamson, 1985). Even as states commit to an alliance, they can also benefit from defecting and taking advantage of allied cooperation. Sometimes the perceived benefits of defection outweigh the long-run benefits of cooperation, so alliance members face an enforcement problem (Fearon, 1998; Koremenos, Lipson and Snidal, 2001).

Alliances generate two forms of opportunism.⁵ First states often violate their alliance commitments and abandon their partners (Berkemeier and Fuhrmann, 2018). As a result, alliance members must reassure partners their commitments are credible. Second, there may be a temptation

⁵Some argue that entrapment is a third form of opportunism (Snyder, 1984), but some evidence suggests entrapment is rare (Kim, 2011; Beckley, 2015)

to free-ride by lowering defense expenditures.⁶ Though states contribute to the collective military capability of an alliance through their military spending, they can also reduce defense spending and rely on their partners (Olson and Zeckhauser, 1966; Morrow, 1993; Conybeare, 1994; Sandler and Hartley, 2001).

As DiGiuseppe and Poast (2016) observe, some alliances have fewer credibility concerns due to members' political regime type. Democracies make more credible commitments, so they assert that defense pacts with democracies lower defense spending. This insight about conditional credibility is a useful starting point because credibility is multifaceted. Depth, unconditional military support (Benson, 2012; Chiba, Johnson and Leeds, 2015) and issue linkages (Long and Leeds, 2006; Poast, 2012, 2013) are all possible sources of credibility.⁷ I emphasize treaty depth as a source of credibility and identify an important tradeoff between reassurance and free-riding. I focus on depth because this single alliance characteristic can predict when alliance participation increases and decreases military spending.

Moreover, treaty depth is a policy choice, while allied democracy is a structural factor. Though states probably do not change their political regime type to reassure allies, they often alter the design of their alliance treaties. More than half of all ATOP alliances with military support have some depth.

In general, alliance members increase the credibility of their commitments by making costly commitments. Costly promises allow alliance members and potential adversaries to infer the credibility of the alliance (Leeds, 2003*b*; Fuhrmann and Sechser, 2014). Reassuring allies through deep and costly defense cooperation reduces the risk of abandonment.

Greater alliance depth does not alleviate free-riding, however. Enforcing cooperation around free-riding is difficult. Normative appeals to common interests rarely work. Though verbal com-

⁶Though the public goods model of alliances has serious theoretical and empirical limitations, it is common practice to describe low defense spending in an alliance as free-riding.

⁷Though the argument only discusses depth, the research design accounts for multiple sources of alliance credibility.

munication or “cheap talk” has value in international politics (Trager, 2010), it is unlikely to overcome incentives to free-ride. Even when they spend less on the military, alliance members retain foreign policy benefits and can reallocate resources to other priorities. The ability to reduce defense spending and spend more on other goods sometimes motivates states to form alliances (Kimball, 2010; Allen and DiGiuseppe, 2013).

Addressing allied free-riding requires leverage. Alliance members gain leverage through either a credible threat of abandonment in response to free-riding or control over allied policies. Policy control of allied military spending decisions occurs when the alliance reflects hierarchical relationships like an informal empire (Lake, 1996). Without such direct influence, states must possess a credible threat to leave the alliance in response to free-riding. Otherwise, free-riding allies will dismiss weaker signals and threats due to uncertainty and incomplete information.

Reassuring allies reduces the credibility of threats to abandon free-riders. States cannot simultaneously reassure their allies and maximize leverage over free-riding. As alliance members use costly commitments to reassure, partners can reduce defense spending more. In less credible treaties, such as alliances between erstwhile rivals, failure to contribute increases the risk of abandonment, so members are less likely to reduce defense spending (Niou and Zeigler, 2019).

Deep alliances highlight this tradeoff between reassurance and free-riding. Stipulating deep cooperation reassures partners and reduces leverage against free-riding. Increasing treaty depth also promotes specialization and efficiency from coordinated defense effort. Compared to shallow alliances, participation in deep alliances will lead to lower percentage changes in military spending.

3.2 Depth of Military Cooperation

Alliance depth is the extent of defense cooperation formalized in the treaty. To be more precise, depth is the extent of policy coordination and military cooperation required by formal alliance treaty obligations. Formal defense cooperation is the primary source of depth, as it stipulates close cooperation between members. By contrast, shallow alliances promise more arms-length military

support.

Defense cooperation in a deep alliance takes many forms. Allies can form an integrated military command, provide military aid, commit to a common defense policy, provide basing rights, set up a formal organization to manage the alliance or undertake companion military agreements. All of these obligations move alliance members away from an arms-length partnership towards close cooperation via policy coordination and regular interaction. These commitments also impose monetary and policy costs on members.

One example of a deep alliance is a 1948 defense pact between the United Kingdom and Jordan, which includes unconditional military support, basing rights, military aid, official military contact, and an Anglo-Transjordan Joint Defense Board. This is a deeper alliance than a 1912 alliance between Greece and Bulgaria which only commits to mutual defense and consultation if either state is attacked by Turkey. Increasing military coordination adds ties between alliance members beyond a promise of military support.

Alliance depth increases the extent of free-riding in two ways. First, adding depth reassures partners, which reduces leverage around free-riding. Deep alliances are more credible because defense cooperation is costly. Making costly commitments of foreign bases, policy coordination, or aid reassures allies. Depth is especially useful because alliance members face a time inconsistency problem. Alliance treaty fulfillment depends largely on shared foreign policy interests (Morrow, 2000; Leeds, 2003a), so changing foreign policy interests threaten alliance fulfillment (Leeds and Savun, 2007). A deep alliance makes a series of repeated transfers, and states can signal commitment by maintaining those transfers.

On the other hand, shallow alliances increase leverage over free-riding. These treaties have some basic credibility from hands-tying signals (Fearon, 1997), as well as audience Morrow (2000) and reputational costs (Gibler, 2008; Crescenzi et al., 2012). Even so, threats to abandon free-riders are more credible than in a deep alliance. In a shallow alliance, members must hedge against abandonment, which partners can use as leverage to discourage free-riding. Realizing gains from

alliance participation in a shallow treaty may actually require increased defense spending (Niou and Zeigler, 2019). As a result, participation in shallow alliances increases military spending.

Efficiency gains is the second way deep alliances increase free-riding. Given a reliable alliance, members can exploit economies of scale by focusing their defense efforts (Leeds, 2003a). Policy coordination facilitates specialization and reduces redundant capabilities. Reducing redundant military capabilities then allows some alliance participants to reduce their defense spending. In a deep alliance, members attain more foreign policy goods with less defense effort.

If deep alliances offer efficiency gains, why are many alliances shallow? Depth comes at the cost of foreign entanglement. Alliance members sacrifice some of their freedom of action in foreign policy in return for the benefits of alliance participation (Altfield, 1984; Snyder, 1997). Deeper military cooperation sharpens this trade off between benefits and foreign policy freedom. Shallow alliances provide fewer direct benefits, but they also have less foreign entanglement. Domestic politics (Davis, 2004), democracy (Chiba, Johnson and Leeds, 2015) and a state's international reputation (Mattes, 2012) may all lead to more arms-length cooperation.

In summary, deep alliances increase free-riding among alliance members. This is especially relevant for non-major powers. These states are more likely to use alliances to reduce defense spending.

3.3 Deep Cooperation and Non-Major Powers

Non-major powers have limited military capabilities and less status in international relations. As a result, they usually focus on ensuring their immediate security. The emphasis on security creates opportunities for exchanges where non-major powers trade foreign policy autonomy for allied protection (Altfield, 1984; Morrow, 1991). By giving non-major powers more security, alliances allow them to reduce defense spending.

Besides their security goals, non-major powers face higher opportunity costs of military spending. The marginal cost per taxpayer of increases in defense spending is decreasing in the number of

taxpayers (Dudley and Montmarquette, 1981), and non-major powers have fewer taxpayers. Small states also have limited economies of scale in military spending (Moravcsik, 1991; Kapstein, 1991; Anderton, 1995; Devore, 2013). These economic factors and non-major powers' foreign policy goals encourage free-riding.

Greater alliance treaty depth makes free-riding more likely. For security-conscious non-major powers, abandonment is a serious concern. Depth reassures non-major powers and allows them to focus their defense efforts.

To illustrate the logic, consider two related alliances from the inter-war period. A 1920 treaty between France and Belgium (ATOPID 2055) added commitments of military aid and a coordinated occupation of the Rhineland to defensive obligations. Given this depth, the Franco-Belgian alliance reduced Belgian defense expenditures. A more limited treaty between France and Poland that only included military support (ATOPID 2135) had no effect on Polish spending.

These brief examples and the argument suggest that treaty depth modifies the impact of alliance participation on non-major power military spending. Greater depth reduces the impact of alliance participation on non-major power military spending. Deeper alliances will lead to lower percentage changes in non-major power military spending than shallow treaties.

HYPOTHESIS 1: AS TREATY DEPTH INCREASES, THE IMPACT OF ALLIANCE PARTICIPATION ON PERCENTAGE CHANGES IN NON-MAJOR POWER MILITARY SPENDING WILL DECREASE.

Hypothesis 1 predicts how percentage changes in non-major power military spending differ between deep and shallow alliances. Percentage changes in military spending express changes in spending as a share of the previous year's defense budget. This variable is an appropriate outcome of interest. Percentage changes express the opportunity costs of military spending. All else equal, a large increase in spending relative to the previous year's defense budget imposes great constraints on other goods. Moreover, percentage changes are easier to compare across states and years.

To understand the consequences of alliance participation, I focus allied capability. The way alliances aggregate capability shapes members' behavior (Fordham and Poast, 2014). Non-major powers free-ride on allied capability, not the treaty itself.

Because my argument focuses on differences between deep and shallow treaties, the research design must measure alliance treaty depth and compare alliances. I use a measurement model to infer treaty depth from formal content, then connect alliances to military spending with a multilevel model. The next section describes the research design in more detail.

4 Research Design

The research design involves two steps. First, I develop a latent measure of alliance treaty depth. Second, I employ that measure in a multilevel model, connecting alliance-level variation with state-level outcomes. I estimate the multilevel model in a sample of non-major powers from 1816 to 2007. The next section describes the measure of alliance treaty depth.

4.1 Measuring Alliance Treaty Depth

Observed alliance commitments reflect the underlying depth of the treaty, as deep treaties promise more military cooperation. Therefore, I use observed alliance characteristics to infer treaty depth, which could produce two measures. One possible measure is an additive index of treaty depth, where treaties with multiple commitments have higher index values. This assumes each indicator is equally important, which is unlikely. Instead, I employ latent variable modeling, which is a more flexible way to use observable characteristics to infer an underlying trait. This approach allows different variables to contribute more or less to depth, while including binary and ordinal variables. The measurement model estimates the correlations between alliance treaty content and the underlying formal depth to predict the depth of each treaty.

Measurement models have a rich history in political science (Clinton, Jackman and Rivers,

2004; Treier and Jackman, 2008; Fariss, 2014). In alliance politics, Benson and Clinton use a mixed factor analysis model to measure alliance scope, depth and capability (Benson and Clinton, 2016; Quinn, 2004). I emulate Benson and Clinton’s approach, but employ different indicators of depth and a different estimator.

I use a Bayesian Gaussian Copula Factor Model (Murray et al., 2013) to measure alliance treaty depth. Murray et al’s model improves inferences from mixed factor analysis for continuous, ordinal, and binary observed data by relaxing distributional assumptions. Given 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. This model breaks the dependence between the latent factors and marginal distributions by using copulas to encode the dependence among the latent variables.⁸ Beyond the semiparametric aspect, this measurement model is a standard mixed factor analysis.

I estimated the measurement model using observed data from 289 alliances with military support in the alliance-level ATOP data (Leeds et al., 2002). I examine the 289 alliances with military support because prior studies of alliance participation and military spending emphasize these treaties. Indicators of treaty depth include military aid, bases, international organization formation, integrated military command, defense policy coordination and commitments to form companion military agreements. The argument suggests there is a single factor underlying variation in all six indicators, so I fit the model with one latent factor.

I used Parameter expanded Gibbs sampling, the default generalized double Pareto (GDP) prior, 20,000 burn-in iterations of the MCMC chain, and 30,000 samples thinned every 30 observations to ensure convergence. The estimates include posterior distributions for the factor loadings and the latent factor.

Figure 1 describes the latent depth of ATOP alliances with defensive or offensive commitments from 1815 to 2016. The posterior mean captures the expected depth of an alliance treaty, condi-

⁸Copulas are a distribution function on $[0, 1]^p$ where each univariate marginal distribution is uniform on $[0, 1]$.

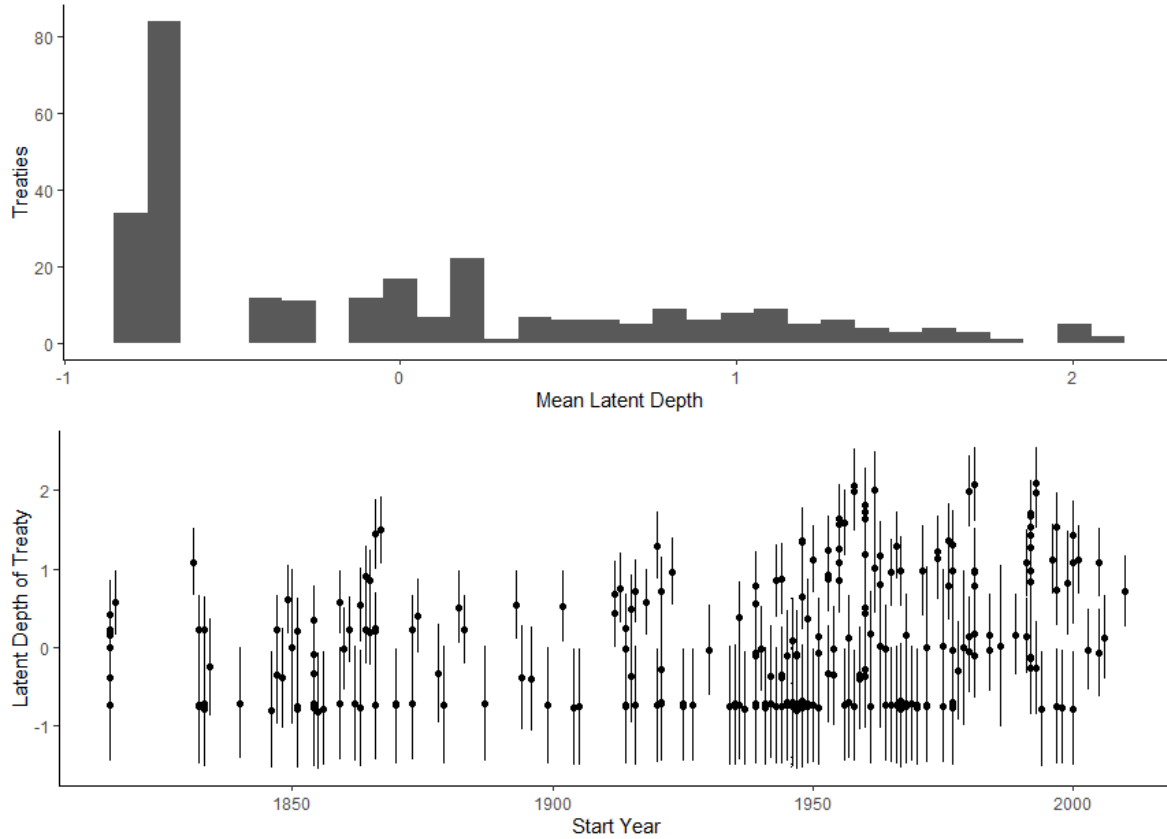


Figure 1: Summary of latent measure of alliance treaty depth for 289 alliances promising military support from 1816 to 2016. The top panel is a histogram of the expected of alliance treaty depth. The bottom panel plots mean treaty depth (points) and the standard deviation (error bars) against the start year of the treaty.

tional on its formal promises. There is substantial variation in the depth of alliance treaties. The top panel of Figure 1 is a histogram of mean treaty depth for alliances promising military support. Many treaties have no deep military cooperation, and are clustered on around -0.8. 171 alliances have a depth score higher than -0.6 as they have at least one source of depth present. The bottom panel of Figure 1 plots the posterior means and uncertainty of the depth estimates against the start year of the treaty. Even after accounting for uncertainty, it is possible to distinguish between some alliances.

Although the values of the latent measure are not intrinsically meaningful, differences between treaties on the latent scale are informative. The median of treaty depth is -0.11, and the mean is

0.02. The median treaty is the Organization of American States (OAS), which includes a formal international organization (ATOP ID 3075). There are many shallow treaties that only include military support. One such alliance is an 1855 pact between France, the UK and Sweden (ATOPID 1190) which only promises defense and consultation.

The three deepest treaties are a 1993 alliance between Russia and Tajikistan (ATOPID 4470), a 1958 alliance between the UAE and Yemen (ATOPID 3345), and a 1981 pact between Gambia and Senegal (ATOPID 3930). All these alliances stipulate extensive defense cooperation. The alliance between Russia and Tajikistan includes military aid, bases, a companion military agreement, and integrated military command. The other two treaties attempted to establish a federation among their members through military support, basing, and defense policy coordination.

The latent measure has some face, concept, and discriminant validity. As an example of face validity, the Gambia-Senegal federation requires deeper cooperation than arms-length commitments of military support. Shallow treaties promise little beyond military support, matching my conceptualization of treaty depth. Last, Figure 1 shows that this measure can distinguish between deep and shallow commitments.

My argument uses variation in treaty depth between alliances to explain percentage changes in military spending. Differences in depth at the alliance level modify the impact of alliance participation on percentage changes in military spending at the state-year level. Therefore I use a multilevel model to estimate the association between treaty depth and military spending. The next section summarizes the multilevel model.

4.2 Multilevel Model

Multilevel modeling bridges levels of analysis (Steenbergen and Jones, 2002; Gelman and Hill, 2007). My model estimates heterogeneous effects of alliance participation on military spending, which are a function of alliance characteristics. I make inferences about how alliance characteristics like formal depth modify the impact of alliance participation on military spending and the

specific impact of individual alliances. To facilitate computation and interpretation, I fit the model using Bayesian estimation in STAN (Carpenter et al., 2016). See the appendix for details of the weakly informative prior distributions and evidence the chains converged.

This research design is more complicated than a traditional panel data model.⁹ But the additional components add substantial value, especially by connecting the argument and research design. I argue that treaty depth modifies the impact of alliance participation on growth in military spending. Therefore, the multilevel model examines that prediction using an alliance-level coefficient that compares deep and shallow alliances.

Standard panel models use a state-level proxy for alliance characteristics, which compares states rather than alliances. This practice of aggregating alliances at the state-year level of analysis may produce misleading inferences (McElreath, 2016, pg. 356). Multilevel modeling retains the structure of the data, where states are members of multiple alliances, and depth is not the only possible source of differences in how alliance participation impacts military spending. Accounting for how multiple alliance characteristics alter the consequences of alliance participation is straightforward in a multilevel model.

Besides connecting alliance and state level variation, the multilevel model generates useful comparisons between alliances by estimating the specific impact of each alliance on members' military expenditures. Aggregating multiple alliances at the state level masks heterogeneous effects of individual treaties. Partial pooling of these alliance-specific parameters generates reasonable estimates for each alliance, which can be used to compare treaties. The next section details the model specification.

4.2.1 Model Specification

This multilevel model connects two distinct regressions. The base is a state-year-level regression, which includes the impact of alliance participation. A second alliance-level regression

⁹See the appendix for results from a range of models with state-level indicators of alliance depth.

modifies the effect of alliance participation on military spending, like an interaction.

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

$$y \sim student_t(\nu, \mu, \sigma) \quad (1)$$

y is the dependent variable— percentage changes in military spending. I model the outcome using a t-distribution with degrees of freedom ν to address heavy tails.¹⁰ σ is analogous to the error term in a frequentist regression as it captures unexplained variation. μ , the mean of the outcome, depends on several factors.

$$\mu = \alpha + \alpha^{st} + \alpha^{yr} + \mathbf{W}_{n \times k} \gamma_{k \times 1} + \mathbf{Z}_{n \times a} \lambda_{a \times 1} \quad (2)$$

Percentage changes in spending are 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 comprise a standard random effects model. The $\mathbf{Z}\lambda$ term incorporates alliance participation.

\mathbf{Z} is a matrix of state participation in alliances. Columns correspond to each of the a alliances in the data, and rows to state-year observations. If a state is not in the alliance, the corresponding cell of the matrix is zero. If a state is part of the alliance in a given year, the matrix element contains the log of total allied military spending, which is normalized by year.¹¹

I use total allied spending in the alliance participation matrix because more capable alliances are more valuable (Johnson, Leeds and Wu, 2015). \mathbf{Z} encodes a quasi-spatial indicator of alliance participation for all a alliances in the data. States can be members of multiple treaties at once, so observations are not neatly nested. This specification allows each alliance to have a unique impact on military spending as states participate in multiple treaties.

λ is a vector of parameters which estimate the impact of participation in specific alliances

¹⁰I estimate ν directly.

¹¹Normalization keeps the parameters on similar scales, which is important for modeling. I selected normalization by comparing models fit with different ways of expressing allied capability. See the appendix for these results.

on military spending. Because the non-zero elements of Z are allied spending, the λ parameters capture alliance members' response to allied capability. Each alliance has a unique λ . The λ parameters have shared distribution, so I assume alliances are similar but different in how they impact military spending.

The second part of the multilevel model uses alliance characteristics to predict how alliance participation is associated with percentage changes in military spending. The λ parameters are the outcome in an alliance-level regression. As a result, the impact of alliance participation on members' military spending depends on treaty characteristics, including depth. In this second-level regression:

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

and

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

In the alliance-level regression, \mathbf{X} is a matrix of the l 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. A larger σ_{all} indicates more variation in how alliance participation impacts military spending. The second-level regression includes treaty depth, and each β parameter modifies the impact of alliance participation on percentage changes in military spending. The β s are like marginal effects in an interaction.

Treaty depth impacts military spending by modifying the consequences of alliance participation. Changing treaty depth shifts λ , which in turn affects military spending. β_1 compares deep and shallow treaties. Hypothesis 1 predicts β_1 will be negative for non-major powers, which implies deep alliances have a more negative effect on military spending.

In this model, the β parameters capture how key alliance characteristics modify the impact of alliance participation on military spending. The λ parameters express the impact of participation

in each alliance, permitting heterogeneous effects of individual treaties. Again, using alliance characteristics to modify the impact of alliance participation matches my conditional argument. I now describe the sample and covariates in the analysis.

4.3 Sample and Covariates

I estimate the multilevel model on a sample of non-major power states from 1816 to 2007. I identify non-major powers using a measure of major power status from the Correlates of War Project. 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 examine these treaties. The sample contains 8,668 observations and 192 alliances.

The dependent variable is percent changes in military spending, which is calculated as:

$$\% \text{ Change Mil. Expend} = \frac{\text{Change Mil. Expend}_t}{\text{Mil. Expend}_{t-1}} \quad (5)$$

I used the Correlates of War Project's data on military spending to measure percentage changes in spending (Singer, 1988).¹² The percentage change 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. To address outliers, I apply the inverse hyperbolic sine transformation to this variable.¹³

Using percent changes in military expenditures as the dependent variable helps the research design. The level of military spending is not stationary for most states, especially in longer panels. Thus, using percentage changes in spending reduces the risk of spurious inferences. Benchmarking changes to prior expenditures also facilitates comparisons across states and over time.

The key independent variable is the mean latent depth of each alliance. This variable enters the model in the alliance-level regression and Hypothesis 1 predicts it will have a negative coefficient.

¹²Estimating the model on different military spending data produces similar results: see the appendix for details.

¹³This transformation applies to positive, negative and zero values. It has minimal impact on values between -1 and 1, but pulls in larger values. Inferences about treaty depth and other alliance characteristics are comparable with and without the transformation.

I also include a series of state and alliance-level controls, which are described in more detail in the appendix. State level controls include likely correlates of alliance participation and military spending. At the alliance level, I adjust for correlates of depth and military spending. Many of these alliance level variables are theoretically interesting in their own right. 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.¹⁴

Because I use Bayesian modeling to estimate the association between treaty depth and percent changes in military spending, each coefficient has a posterior distribution—the likely values of the coefficient conditional on the priors and observed data. There are no indicators of statistical significance. Instead, Figure 2 summarizes the 90% credible intervals of the parameters, and I calculate the negative posterior probability for the treaty depth coefficient to assess Hypothesis 1.

The preponderance of evidence matches the predictions of Hypothesis 1. There is a 96% chance treaty depth is negatively associated with percent changes in military spending for non-major powers. The 90% credible interval for treaty depth does not include zero, though it is close. This is one important indicator that participation in a deep alliance increases non-major power military spending, relative to a shallow alliance.

Treaty depth also has a substantively important effect, which I assessed by simulating the effect of changing treaty depth from the minimum value of -0.8 to 1, which is in the third quartile. Holding other alliance covariates at their means, this change in depth reduces a hypothetical λ by

¹⁴See the appendix for more details on convergence and other robustness checks.

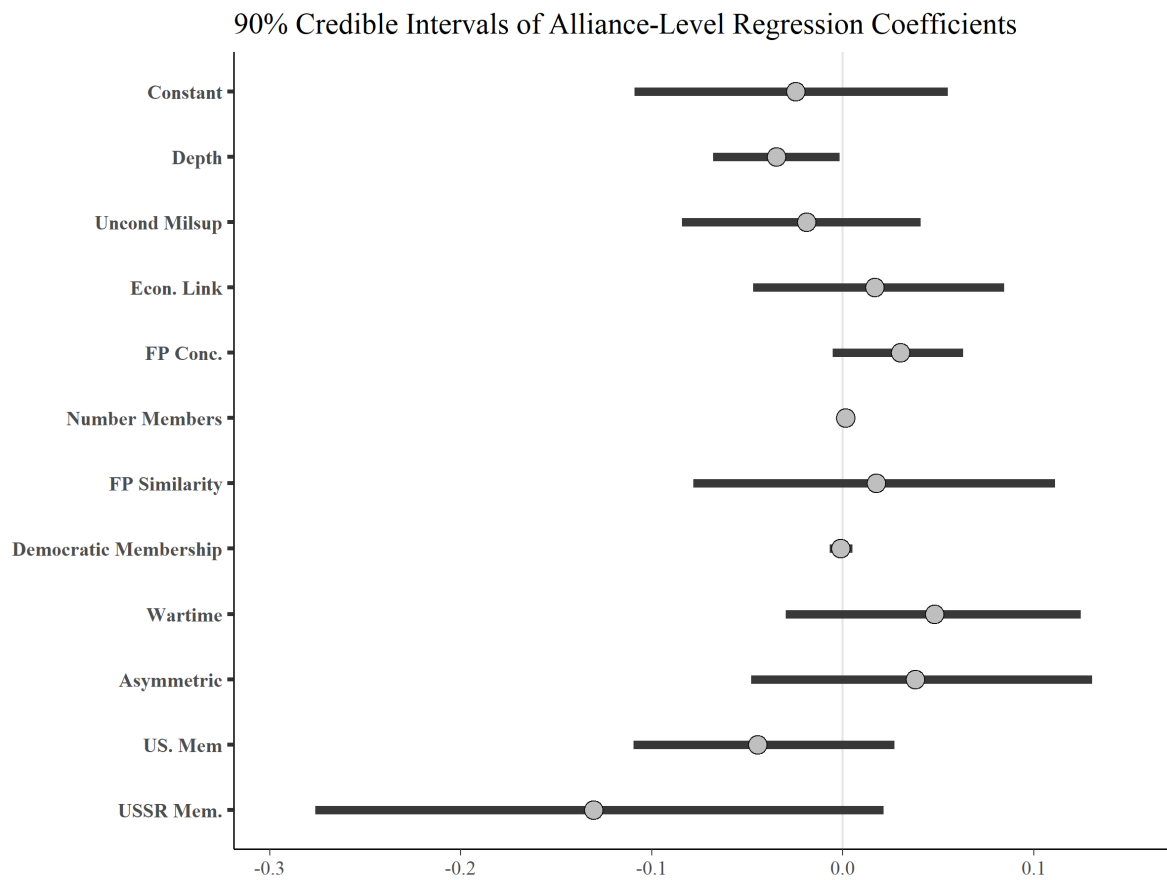


Figure 2: 90% credible intervals to summarize the posterior densities of coefficients in the alliance-level regression. Points mark the posterior mean, and the bars encapsulate the width of the credible interval.

.06 in expectation. As a result of this change in λ , the model predicts alliance members' military spending would fall by .02, for an alliance with median capability. The 90% credible interval of this predicted difference in percentage changes in military spending due to an increase in treaty depth ranges from -0.04 to -0.001.

The substantive importance of treaty depth is reflected by patterns in the λ parameters. Each λ measures the impact of treaty participation. If treaty depth has a large influence on alliance participation, it will appear in the λ estimates. There should be a negative trend in the expected value of λ as treaty depth increases in non-major power alliances. On average, deep alliances should have a negative effect on members' percent changes in military spending and shallow alliances should have a positive effect.

Figure 3 plots the expected value of λ across the range of treaty depth. For non-major powers, the trend is negative. The correlation of -0.5 between mean λ and treaty depth matches the logic of Hypotheses 1. Participation in shallow treaties often increases percentage changes in military spending among non-major powers, while most deep treaties have a negative effect. Because other treaty characteristics and unmeasured factors also influence the λ estimates, Figure 3 shows tremendous variation in how alliance participation impacts non-major power military spending.

In summary, I find that treaty depth decreases the impact of alliance participation on military spending. Deep alliances reduce members military spending, while shallow alliances often increase it. This has important consequences for our understanding of alliance participation and military spending.

6 Discussion

My findings add to our understanding of alliance participation and military spending and address debates over whether alliance participation increases or decreases military spending. Claims alliance participation only increases or decreases military spending are incomplete. My argu-

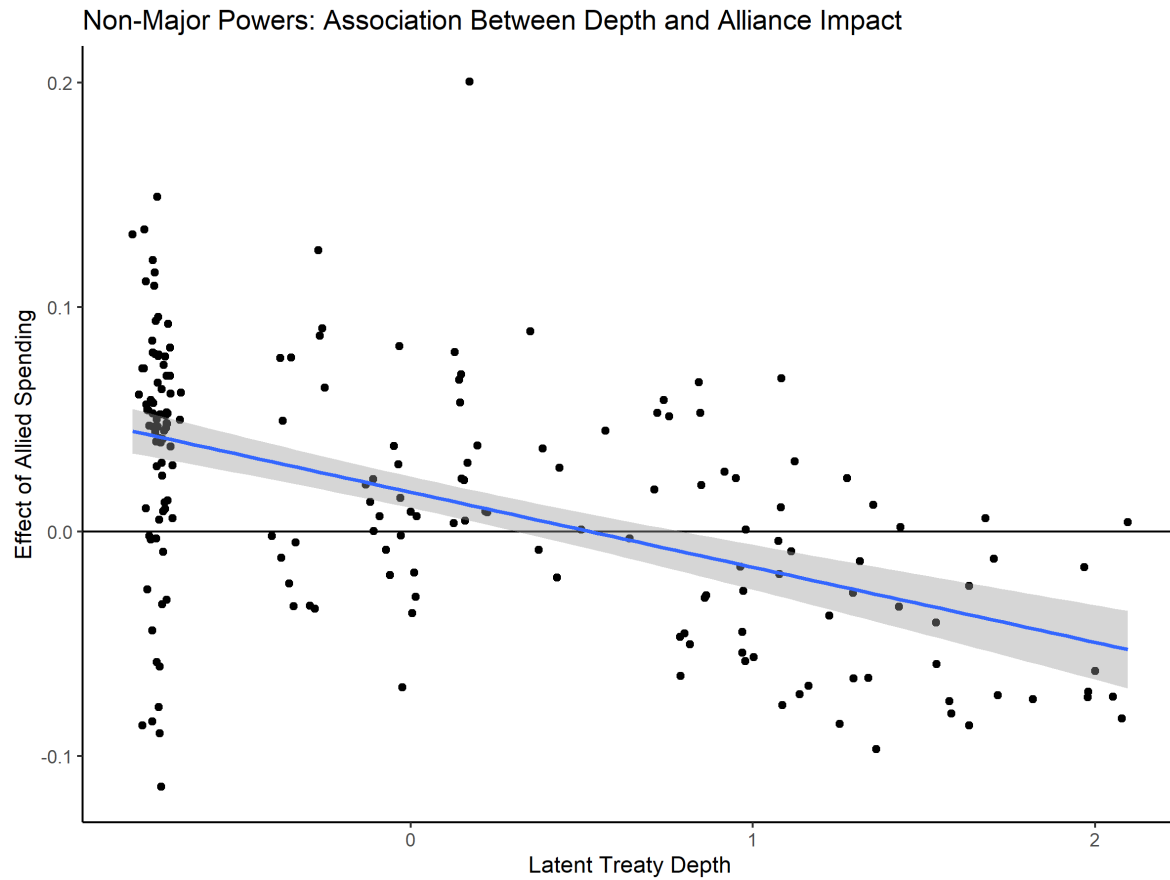


Figure 3: Scatter plots of trends in mean λ parameters and treaty depth in peacetime alliances. λ is the total impact of alliance participation on percent changes in military spending. For non-major powers, λ decreases as treaty depth rises. Trend line estimated using linear regression.

ment builds on other conditional arguments about alliance participation and military spending (DiGiuseppe and Poast, 2016). I show how treaty depth modifies the impact of alliance participation on military spending. Participation in a deep alliance often reduces defense spending. Joining a shallow treaty is more likely to increase defense spending.

How do the findings compare to prior evidence on alliance participation and military spending? Connecting my results with earlier evidence requires renewed attention to specific and general research designs. General studies compare states in an alliance to those without one. Specific studies estimate responsiveness to allied military spending in a few treaties.

The results encompass specific and general studies, as I estimate both the impact of individual treaties and general differences between treaties. My research design emulates specific studies by estimating the unique impact of participation in individual treaties, relative to no alliance. The alliance-level coefficients compare treaties to assess the general role of alliance characteristics. How joining an alliance affects military spending depends on depth and other alliance characteristics.

My findings only address formal treaty depth, however. The measure of treaty depth only includes formal promises, in part because informal depth is harder to observe. As a result, my test of alliance depth may be conservative—it does not capture phenomena that should have a similar effect.

Strategic alliance design is another possible weakness of the test. Non-random selection into different alliances could produce systematic differences between members that are not captured for in my statistical model. I attempted to control for correlates of alliance treaty depth, but oversights are possible.

Despite these limitations, the argument and results provide valuable insights about alliance participation and military spending. I explain when alliance participation is associated with more or less military spending among non-major powers, addressing debate between contradictory views of alliances. I provide evidence that how alliance participation impacts military spending depends

on state capability and alliance treaty depth using a new measure of alliance treaty depth and a multilevel model. The argument and findings have implications for scholars and policymakers.

7 Conclusion

Alliance participation does not uniformly increase or decrease military spending. Deep alliance treaties reduce the impact of alliance participation on non-major power defense expenditures. As a result, there is a tradeoff between reassurance and free-riding in alliances.

There are several implications of my findings. First, they reinforce the importance of accounting for heterogeneity among alliances. Alliances have heterogeneous effects on the risk of war, trade and military spending (Leeds, 2003*b*; Long and Leeds, 2006; Benson, 2012; DiGiuseppe and Poast, 2016).

Another implication is the distributional consequences of changes in military spending within states and among alliance members. By altering military spending, alliance design changes the domestic political economy of member states. The economic consequences of alliance participation are a possible subject for future research.

Besides their scholarly value, the argument and evidence help inform policy debates. Tradeoffs in alliance treaty design can guide our understanding of why some treaties lead to free-riding and possible policy responses. Reassurance from deep alliances increases free-riding. States can use deep cooperation to increase alliance credibility, but they lose leverage to check free-riding as a result.

The United States is currently wrestling with the implications of treaty depth. Washington has often decried free-riding by allies who provide too little for their own defense (Lanoszka, 2015). But allies are able to free-ride partly because the United States makes deep commitments. Attempts to reassure NATO allies may outweigh the agreement for all allies to spend at least 2% of GDP on defense, for instance.

Reducing the depth of US alliances could generate credibility problems, however. Free-riding may be the price of credible commitments. Therefore, this paper reveals a tradeoff— it is not an unconditional call to reduce the depth of US alliance commitments. Adjusting existing treaties may be more difficult than designing new alliances and will have other ramifications. The full consequences of shifting treaty depth require additional scrutiny.

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