

# Summary of Previous Empirical Work on the Arms-Alliances Tradeoff

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July 25, 2018

## 1 Introduction

How does membership in an international alliance affect a state's military spending? There are two competing answers to this question. One group expects that alliance membership leads to reductions in spending, while the other predicts that alliance membership increases military expenditures.

The modal perspective is that the two predictions are incompatible, which has stunted theoretical development. The predictions themselves are clear, but the models behind these predictions have different strengths and weaknesses. Furthermore, our ability to assess each prediction has been complicated by serious shortcomings in research design, as many tests use misspecified statistical models or inappropriate samples. As a result, there is ample room for theoretical and empirical progress in our understanding of how alliance membership affects military spending.

To understand current models of alliance membership and military spending, we can situate them in a general framework. Predictions of increased or decreased military spending from alliance participation rely on concepts from a standard utility maximization model in microeconomics. In this model, an actor maximizes their satisfaction from consuming two different goods given their preferences and constraints. Preferences over combinations of the two goods are represented by an indifference curve. The prices of each good and the actor's budget constrain how much they can consume.

This model predicts that the actor will spend their whole budget on some combination of the two goods to maximize their utility. Because the entire budget is spent, changes in the consumption of the two goods are connected, as long as the budget remains the same. If the price of one good decreases, and consumption of the other decreases, the two goods are substitutes. But if one good becomes more affordable and consumption of the other increases, the two goods are complements.

In international relations, states consume arms or alliances to increase their security, subject to their resource constraints. So states are the actors, while arms and alliances are the goods

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they consume. The prediction that alliance membership and defense spending are negatively correlated implies that the two policies are substitutes— increased consumption of alliances leads to decreased consumption of arms. If alliance participation is positively correlated with military spending, then the two policies are complements, as increased consumption of alliances leads to increased consumption of arms.

There are several different models behind predictions of substitution and complementarity. Scholars have used a private goods model of foreign policy substitution and a public goods model to explain substitution of alliances for arms. Models of complementarity are less well developed, but the most general relies on an income effect, whereby alliance membership makes military spending more valuable. The rest of this paper explains and critiques these models in more detail.

The first section of this review summarizes explanations and evidence for the prediction that arms and alliances are substitutes. The second section details explanations and evidence for expectations of complementarity. The third section draws conclusions about our knowledge of the relationship between arms and alliances, and suggests directions for future research.

## **2 Arms and Alliances as Substitutes**

Most academics and popular discourse holds that alliance membership leads to reductions in military spending. There are two distinct explanations of the process behind this substitution of alliances for arms. The substitution theory of foreign policy rely on the fact that arms and alliances both provide security to explain substitution. The public goods theory of alliances, also known as the economic theory of alliances, argues that the security alliances produce is a public good, which generates incentives for members to free-ride on the defense spending of their peers.

Both models of substitution use the opportunity costs of military spending to explain why alliance members have the incentive to reduce military spending. Every dollar spent on the military cannot be spent on other policies (Powell, 1993; Jackson and Morelli, 2008; Fearon, 2018). Although military spending can have some positive externalities (Whitten and Williams, 2011), it at best has a mixed association with economic growth (Deger and Sen, 1995; Shin and Ward, 1999; Scanlan and Jenkins, 2001; Alptekin and Levine, 2012). For leaders seeking to provide public and private goods to supporters, reductions in military spending increase funding for other policies.<sup>1</sup> Alliance membership provides additional security, which gives leaders the freedom to cut military spending and reallocate those funds to other policies.

Although they make similar predictions, there are significant differences between the two models, which means they must be addressed separately. The policy and academic implications of substitution theory of foreign policy are quite different from those of the public goods theory of alliances. If the security from an alliance is a public good, then alliances are collective security organizations. Because public goods theory predicts free-riding, it has a morally charged implication that alliance members are shirking their duty to maintain collective security. But if security is specific to individual states, then reduced defense spending is less morally problematic. Substitution theory of foreign policy focuses on security for individual states, and I summarize that logic first.

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<sup>1</sup>Military-led regimes are a notable exception to this pattern.

## **2.1 Substitution Theory of Foreign Policy**

The core insight behind substitution theory of foreign policy is simple—states can use multiple policies to attain their goals (Most and Starr, 1989). For example, to increase their prosperity, states can adjust their exchange rates, trade policies, or investment regulations. The mix of policies states choose depends on the relative efficacy of each policy, the costs of implementation, and their available resources.

Security from external threat is one of the most important goals for states. In an anarchic international system, states regularly confront the prospect of armed conflict. Losing a war creates substantial costs in lost resources and foreign policy freedom. So security depends on the ability of states to successfully prosecute a war, and military capability is a crucial determinant of success in conflict. While success in conflict is not guaranteed by a preponderance of capability (Arreguin-Toft, 2005; Sullivan, 2012), states with more troops and military resources tend to win in international conflict. Therefore, states consider the balance of forces before initiating international conflicts, and states can use arms or alliances to shift that balance in their favor.

Domestic military spending and international alliances both provide military capability, which increases a state's security (Morrow, 1993). Alliances provide access to the capabilities of other states through promises of support in the event of a conflict. Military expenditures can be used to build or import weapons, train soldiers, and provide other defense goods.

States then balance the costs and efficiency of arms and alliances (Morrow, 1993; Conybeare, 1994). If forming an alliance provides adequate capability, states can rely on allied capability for security instead of devoting more resources to the military. When states gain extra security from an alliance, they can reduce military spending and reallocate those resources to other policies. Therefore, substitution theory of foreign policy expects that alliance participation leads to decreased defense expenditures.

DiGiuseppe and Poast (2016) extend this theory of substitution by noting that alliance credibility may modify the relationship between arms and alliances. They argue that states will only reduce military spending if they believe their allies will honor their treaty obligations, and that because democracies make more credible commitments than other states, defense treaties with democracies will produce substitution. The overall logic of substitution theory of foreign policy is clear, but what evidence is there for its prediction that alliance membership leads to less military spending?

### **2.1.1 Evidence**

There are few tests of the substitution theory of foreign policy theory in the case of arms and alliances. Testing predictions from substitution theories of foreign policy is challenging, because specifying the exact behavioral outcomes is difficult (Starr, 2000). Most studies have tried to establish an association between alliance membership and military spending using a variety of samples and techniques.

Case studies of Great Power relations in Europe during the 1860s (Morrow, 1993) and Egypt during the Cold War (Barnett and Levy, 1991) suggest that states can tradeoff between domestic investment in arms and alliance membership. However, Most and Siverson (1987) find no association

between allied spending and domestic military spending using regressions and cross-tabulations of Great Power spending in Europe from 1870 to 1914. Sorokin (1994) applies a two-stage generalized least squares model to four separate time series of military spending in Austria-Hungary and France from 1880 to 1913 as well as Syria and Israel from 1963 to 1988, and finds that France and Syria responded to increases in allied spending by reducing their own military expenditures. Last, Conybeare (1994) finds that great powers with more demanding alliance obligations have lower ratios of military manpower to allied manpower. The focus on individual countries and alliances in these models leaves us with one general empirical model of substitution

DiGiuseppe and Poast (2016) use a panel data regression with a lagged DV, panel-specific autocorrelation correction, and robust set of control variables to test whether membership in a defense pact with a democracy leads to decreased military spending. They find a robust negative association between defense pacts with a democracy and military spending in a sample of all states in the international system from 1950 to 2001.<sup>2</sup> DiGiuseppe and Poast's results support the idea that states only substitute alliances for arms in particular circumstances. Therefore, substitution theory of foreign policy has some explanatory power, which is reinforced by tests of a different prediction of the theory.

Another implication of substitution theory of foreign policy is that when the costs of domestic arms are high, states will form alliances to increase their security instead. Two studies test this prediction using panel data.<sup>3</sup> Kimball (2010) finds that high demand for social policies, which she measures using the infant mortality rate, increases the propensity of a state to form an alliance in a given year. Allen and DiGiuseppe (2013) argue that limited access to credit will increase the opportunity costs of military spending, and find that states suffering an external debt crisis are also more likely to form alliances. Neither theory and research design can rule out the alternative argument that states with serious economic difficulties form alliances to secure economic aid from larger partners. These studies provide some tentative evidence for another prediction of the substitution theory of foreign policy, which increases the plausibility of that argument.

Overall, the logic of substitution theory of foreign policy and associated empirical results suggest that this model contains useful insights about the relationship between alliance membership and military spending. Because both arms and alliances provide military capability, and military spending has domestic opportunity costs, the incentive for states to rely on allied military spending instead of their own is clear. The public goods theory of alliances also predicts that alliance membership leads to reduced military spending, but uses a different process.

## 2.2 Public Goods Theory of Alliances

Also known as the economic theory of alliances, public goods theory starts with the premise that security from an alliance is a collective good for members (Olson and Zeckhauser, 1966). Collective or public goods have two key characteristics, non-excludability and non-rivalry. Consumption of alliance security is non-excludable—denying another alliance member protection

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<sup>2</sup>The only remaining threat to inference I can think of is selection on unobservables (Chaudoin, Hays and Hicks, 2016), which I'm in the process of checking.

<sup>3</sup>The use of panel data in work on alliance formation is somewhat unusual, and the probit models in these studies do not fit the data well.

from the pact undermines the purpose of the treaty. Because alliance security is non-rival, consumption of security by one member does not reduce the security available to other members.

Public goods theory treats each alliance member's military spending as a contribution to collective security. Alliances aggregate the capability of their members, so the total capability of an alliance depends on members' military expenditures. By spending on their military, members provide the alliance with additional capability and increase the amount of security the treaty provides. But because alliance security is a public good, its provision is subject to a collective action problem.

In a collective action problem, individual contributions provide a benefit for all, but individual benefits are smaller, which creates an incentive to rely on others to provide the public good. Inadequate provision of the public good follows as individuals pursue their narrow interests. In alliances, individual members have incentives to rely on the other states to provide the necessary capability, and reduce their own military spending. By reducing military spending, alliance members can consume more non-defense goods, but this also reduces the security from the alliance.

Relying on others' contributions to a public good is called free-riding. If free-riding applies to alliances, it will be reflected in military spending. Olson and Zeckhauser (1966) focus on the defense burden—military expenditures as a share of GDP. Given the collective action problem, they expect that larger members of the alliance will bear a higher defense burden, because they value the security from the alliance more. The public goods theory of alliances predicts that economic size and the defense burden will be positively correlated—larger alliance members will spend a higher share of their resources on defense.

An extension of the public goods theory of alliances argues that military spending produces public and private goods for states (Hansen, Murdoch and Sandler, 1990; Murdoch, 1995). In this joint product model, some military spending provides for collective security through alliances, which is the public good. Other spending provides private goods such as internal control, border security, and particular deterrence. The joint product model expects that as states reap more private benefits from military spending, their defense burden will increase (Sandler and Hartley, 2001), and alliance members will only free-ride in military spending for collective security.

### **2.2.1 Evidence**

The public goods theory of alliances predicts that among alliance members, larger states will have a higher defense burden. The key independent variable is Gross Domestic Product (GDP) or Gross National Product (GNP), both of which measure economic size. Defense spending as a share of GDP or GNP is the dependent variable.

Because Olson and Zeckhauser (1966) first tested their claims of free-riding on the North Atlantic Treaty Organization (NATO), and NATO members have quality economic and military spending data, many tests of the public goods theory of alliances look only at NATO.<sup>4</sup> Other scholars have examined alliances besides NATO, where some find evidence of disproportionate military expenditures, while others do not. Table 1 details the results of previous studies of free-riding in alliances.

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<sup>4</sup>In the interest of parsimony, I include only a representative sample of papers on free-riding in NATO.

	Free-Riding	Alliance Scope
Olson and Zeckhauser (1966)	Yes	NATO 1964
Starr (1974)	Yes	Warsaw Pact 1967-1971
Reisinger (1983)	No	Warsaw Pact 1970-1978
Thies (1987)	Mixed	Seven pre-1945 Alliances
Conybeare and Sandler (1990)	No	Triple Alliance & Triple Entente 1880-1914
Palmer (1990)	No	NATO 1950-1978
Chen, Feng and Masroori (1996)	No	Arab League 1950-1988
Oneal and Whatley (1996)	Yes	NATO, Rio Pact & Arab League 1953-1988
Siroky (2012)	No	Quintuple Alliance Members 1820
Plümper and Neumayer (2015)	Yes	NATO 1956-1988

Table 1: Findings on Free-Riding in Alliances. Most of these studies use military expenditures as a share of GDP for the dependent variable, and assess whether it is correlated with economic size. A positive correlation between GDP or GNP and the defense burden among alliance members is the standard evidence of free-riding.

There is mixed evidence of free-riding across these ten studies. While most studies of NATO find the expected positive correlation between GDP and defense burdens, the correlation is less consistent in other contexts. Free-riding is absent among front-line Arab League members, the Triple Alliance, Triple Entente, and the Quintuple Alliance. Differences in results across studies could reflect contextual differences or problems in estimating correlations between GDP and the defense burden.

Interpreting regression models with a ratio dependent variable is difficult, because it is impossible to identify whether changes in the numerator or denominator are driving the results. GDP is part of the dependent and independent variables, which further complicates interpretation of the coefficients in a regression model. Larger states also have broad foreign policy interests that include multiple alliances, so their defense burden reflects more than their contribution to a single alliance.

Plümper and Neumayer (2015) avoid these identification problems and provide the best evidence of free-riding in NATO by estimating a quasi-spatial model of how growth in NATO members military spending responds to US and Soviet spending. In this model, a lack of responsiveness to increasing Soviet spending implies free-riding on US protection. They find that many NATO members did not increase their military spending when Soviet spending exceeded US spending, and that the extent of free-riding is a function of proximity to the Warsaw Pact. Crucially, their estimates of the degree of free riding are uncorrelated with GDP, which contradicts Olson and Zeckhauser's expectation that smaller states are more likely to free ride.

Due to their focus on free riding, public goods theories of alliances have added little to our understanding of how alliance participation affects military spending. The main observable implication of public goods theory creates serious identification problems in research design, and is not supported in the best-identified model (Plümper and Neumayer, 2015). Moreover, the concept of free-riding itself is problematic in the context of alliances. Alliance treaties reflect exchanges or bargains among members, and one possible bargain is a security-autonomy tradeoff, where smaller

members give up foreign policy freedom in exchange for protection (Morrow, 1991). For example, European defense spending has remained low in part because the US made its protection conditional on European states not pursuing independent nuclear capabilities (Lanoszka, 2015). These shortcomings have important consequences for our overall understanding of the prediction that alliance membership reduces military spending, which I address in the next section.

## 2.3 Assessment of the Substitution Prediction

Of the two models that predict alliance membership reduces military spending, substitution theory of foreign policy contains more useful insights. By treating security as a private good for states, substitution theories of foreign policy avoided debates over free-riding and burden sharing. Even given its internal cohesion, there are several gaps in our understanding of the substitution theory of foreign policy in the arms-alliance tradeoff. Mixed results from tests of substitution theories of foreign policy and public goods theories in different samples, coupled with the theory and results of DiGiuseppe and Poast (2016) suggest a conditional negative association between alliance membership and military spending. Alliance participation may not always reduce military spending because arms and alliances are imperfect substitutes.

Military spending and alliances provide capability in different ways, so the policies differ in their speed and reliability. States can rely on their own arms in any contingency, but domestic military capabilities take a long time to develop. Because alliance members have divergent foreign policy interests and do not always fulfill their commitments,<sup>5</sup> alliances are a less reliable source of capability than domestic arms, but provide immediate capability gains. The moment a treaty enters into force, alliance members gain their partners support with some probability.

Imperfect substitution between arms and alliances has important consequences for our models of how alliance membership affects military spending. If a state believes its allies will honor their treaty obligations, then that treaty is more like domestic military arms— a highly reliable source of capability. DiGiuseppe and Poast (2016) use this aspect of imperfect substitution explain their prediction that defense pacts with democratic states will lead to substitution, as democracies provide more credible commitments than other states.

The other component of imperfect substitution is how quickly states develop domestic military capability. The faster states can convert military expenditures into capability by training troops and building weapons, the better domestic arms substitute for immediate capability gains from an alliance. The implications of speed and cost in converting defense investments into military capability for alliance participation have not been addressed, and examining this question would add further evidence to our assessment of the substitution theory of foreign policy.

Another unexplored aspect of imperfect substitution is differences between the costs of arms and alliances. States bear different costs when they use arms or alliances to build capability. Military spending employs financial resources and human capital. Alliances impose limit members' freedom of action in foreign policy.

Substitution theory of foreign policy predicts that as alliance participation becomes more costly, states will rely more on military spending for security. Outside of one case study (Morrow, 1993),

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<sup>5</sup>Recent estimates suggest that about 50% of alliance commitments are honored (Berkemeier and Fuhrmann, 2018).

there are no tests of this prediction, due to the difficulty of measuring lost foreign policy autonomy from an alliance. Therefore, how the costs of alliances affect military spending is another important gap in our assessment of the substitution theory of foreign policy.

Imperfect substitution of arms for alliances can also motivate a different prediction of how alliance membership affects military spending. In the microeconomic utility maximization model, when two goods are perfect substitutes, one is a perfect replacement for the other. When two goods are perfect complements, one cannot replace the other. Imperfect substitute goods fall between perfect substitutes and perfect complements, and some scholars have argued that arms and alliances are complements, not substitutes. In the next section, I address the prediction of complementarity between arms and alliances.

### **3 Arms and Alliances as Complements**

If arms and alliances are complements, then alliance participation will lead to increased military spending. This prediction contradicts the unconditional expectations of the substitution theory of foreign policy and public goods theories of alliances. Most authors in this literature frame their work as a more general competitors to models of substitution.

If alliance participation can increase military spending, then the common perception that alliances lead to reduced spending or free-riding should be revised. The prediction of substitution is better known than complementarity, due to the salience of debates over burden-sharing in NATO. Rather than competing with models of substitution, models of complementarity contain different insights about how alliance participation affects defense effort.

Substitution models emphasize domestic political incentives to use alliances as a substitute for military spending. Models of complementarity argue that alliances expand what a state can achieve in international relations. There are three models of complementarity which share this focus on the foreign policy gains from alliances.

#### **3.1 Models of Complementarity**

The prediction that alliance membership leads to increased military spending began with the intuition that dominant models of substitution and free-riding were incomplete. Most models acknowledge that substitution is possible, but then argue that in many circumstances, arms and alliances are complements. Unfortunately, it is hard to compare results from tests of these theories with results from tests of substitution, due to problems in research design. Still, models of complementarity contain some useful theoretical insights.

##### **3.1.1 Diehl 1994**

Diehl (1994) argues that arms and alliances are imperfect substitutes, so alliance participation can lead to increased military spending. Because arms and alliances are imperfect substitutes, he notes that each policy has different motives besides external threat. States can also import



arms or negotiate their grievances in response to an external threat, which weakens the extent of substitution between arms and alliances.

Although Diehl argues that substitution is weaker than other models of the arms-alliances trade-off predict, he acknowledges it is possible. The major contribution of the paper is describing two mechanisms by which alliance participation leads to increased military spending. First, joining an alliance can increase a state's foreign policy responsibilities. After forming a treaty, states may deploy troops abroad, spend more on particular weapons to meet threats from their ally's other enemies, or become involved in conflict, all of which will increase military spending. States also form alliances to support other states, not to enhance their own security, which can require additional spending to back their new partner.

The second mechanism is related to the first. If alliance participation leads to reduced military spending by smaller states, larger partners will need to increase spending to ensure the alliance continues to provide adequate security. As larger states form alliances to increase their autonomy, or freedom of action in foreign policy (Morrow, 1991), the price of this change may be increased spending to ensure the security of client states. As a result, alliance participation is especially likely to increase military spending in larger states as they pick up the slack of their smaller partners.

To test his predictions, Diehl examines a set of major power rivalries from 1816 to 1976, because these cases have a salient external threat and these states can use alliances as substitutes or complements for arms. The unit of analysis is the rivalry year, and the change in each rival's military spending is the dependent variable. Because many great powers are part of multiple rivalries at a time, many annual great-power observations are repeated in this dataset. For example, there are three observations of Japan's changes in military spending in 1937, due to Japan's participation in rivalries with the UK, US, and USSR in that year. Diehl's t-tests and regression models treat these repeated observations as independent of one another, which is untenable.

Furthermore, the sample of major power rivalries selects cases based on the dependent variable, which is likely to result in biased coefficient estimates. Therefore, Diehl's reported results are not trustworthy. The focus on major-power rivalry years also makes it difficult to compare these results with results from state-year panel data. Despite shortcomings in Diehl's research design, his theoretical insight that alliances can increase a state's foreign policy obligations and require increased defense spending is useful. Morgan and Palmer (2006)'s work shares the same characteristics—an interesting theoretical insight and poor research design.

### **3.1.2 Morgan and Palmer 2006**

Morgan and Palmer's expectations about the relationship between arms and alliances are derived from a general model of foreign policy. Due to the scope of the theory, it is necessary to describe the whole model in some detail. After describing their "two-good" model of foreign policy, I turn to the mechanism behind their prediction that alliance participation increases military spending.

The first premise of this model is simple—states formulate foreign policy with reference to the status quo in international politics. The status quo encompasses multiple issue areas, where states can seek maintenance or change. Maintenance seeks to keep favorable parts of the status quo on an issue. Change seeks to alter unfavorable aspects of the status quo, and all states have a mix of

maintenance and change objectives.

To maximize their satisfaction from foreign policy, states will expend all available foreign policy resources to produce a mix of maintenance and change. Because the entire foreign policy budget is spent, there is a tradeoff between the two goals— more maintenance in one area requires less resources for change in another. This tradeoff between maintenance and change matches the predictions of the two-good utility maximization model, where states spending their entire budget to maximize consumption of two goods.

In international relations, states produce maintenance and change by allocating resources to foreign policy instruments such as military spending, alliances, foreign aid, or negotiations. Some policies produce more maintenance, while others produce more change. Shifts in the overall foreign policy budget are the primary cause of changes in allocation of resources to particular policies (Morgan and Palmer, 2000).

An increase in the resources a state can spend on foreign policy will lead to an increase in resources for most policies. Absent a change in state preferences, the relative importance of each policy in the total foreign policy portfolio will remain the same. Given additional resources to spend on foreign policy, Morgan and Palmer expect that states will increase their use of multiple policies simultaneously.

Alliances expand a state's foreign policy budget, by providing more resources to pursue foreign policy goals. By expanding what a state can achieve in international politics, alliances allow states to devote more resources to other policies, like military spending (Morgan and Palmer, 2003). As an illustrative example, Morgan and Palmer argue that an alliance with the US allowed Britain and France to pursue change in the Middle East during the 1957 Suez crisis. Without US protection, Britain and France would have needed to spend more protecting themselves from the Soviet Union, but instead they used military resources to reverse the nationalization of the Suez Canal.

The crux of Morgan and Palmer's argument is that "if an alliance enables a state to produce its desired foreign policy goods with fewer resources than it could otherwise, this actually frees resources for the pursuit of additional goals." This income effect, where alliances allow their members to realize more of their foreign policy goals, is the key mechanism behind Morgan and Palmer's expectation that alliance membership leads to increased military spending. As a final step, Morgan and Palmer justify why complementarity between arms and alliances is more likely than substitution.

Morgan and Palmer acknowledge the key insight from the substitution theory of foreign policy— states can use multiple policy instruments to realize a particular goal. To incorporate substitution into their model, they assume that states employ the most efficient policy for a particular goal, given their resource constraints. Put differently, states use the policy that gets them the most maintenance or change at the lowest cost.

Because foreign policy resources are already allocated optimally, substitution of one policy instrument for another is rare in this model. Morgan and Palmer only expect states to transfer resources from one policy to another if the relative efficiency of those policies has changed. For example, security-seeking states would only spend less on domestic arms and rely more on alliances if alliances became a more efficient provider of security relative to arms. They then assert that changes in the relative efficiency of policies are rare, and that complementarity between poli-

cies is more common, because changes in resources are commonplace.

Morgan and Palmer test their expectation that on average alliances lead to increased military spending using a generalized least squares regression model.<sup>6</sup> The dependent variable is changes in military spending. The key independent variables are a state's power, the power gained from an alliance, and their interaction, so interpretation focuses on marginal effects. Power is measured using CINC scores, which capture a state's share of material capabilities in the international system, and alliance power is the weighted sum of allied states' power.

Morgan and Palmer find that the marginal effect of joining an alliance on military spending is positive for all states. Unfortunately, they do not report uncertainty estimates for these marginal effects, so their comparisons of the effects of different alliances are not meaningful (Brambor, Clark and Golder, 2006). The estimated marginal effects are also based on a regression model with no control variables. Because the model omits variables that are correlated with military spending and alliance behavior, such as threat level and international conflict involvement, the coefficient estimates are biased.

Furthermore, Morgan and Palmer test their expectations in a problematic sample. They focus on all states whose alliance portfolio changed from 1816 to 1992, and measure changes in military spending for four years after the portfolio changes took effect. The use of four-year period after a change in an alliance portfolio is arbitrary. The estimation sample includes 858 observations, which implies only 214 instances of alliance portfolio change.

From 1816 to 1992 there are 367 alliances in the Correlates of War project's alliance data. The formation of each of these alliances alone is a change in the portfolio of each member. If all alliances had two members, and Morgan and Palmer measured 4 years after the formation of each, there would be 2,936 observations in the sample.

If formation, dissolution and changing membership of an alliance all change a state's alliance portfolio, there should be thousands of observations in Morgan and Palmer's sample.<sup>7</sup> Therefore, the number of observations in Morgan and Palmer's sample is far lower than what their description of the research design suggests. This disparity between the stated research design and the estimation sample reduces the face validity of the results and raises the risk of sample selection bias.

Due to research design flaws, Morgan and Palmer's estimates of the relationship between alliance participation and military spending are invalid. The theoretical insights that alliances expand what a state can achieve in international politics and states pursue both maintenance and change are helpful, however. The next model of complementarity between arms and alliances argues that small states use increased military spending to make themselves a more attractive alliance partner.

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<sup>6</sup>The book tests other predictions of their theory, but I focus on Table 3 in Morgan and Palmer (2003), which is also Table A.4 in Morgan and Palmer (2006).

<sup>7</sup>This applies even if most alliances involve major powers. NATO alone could produce 300 observations.

### 3.1.3 Horowitz et al 2017

### 3.1.4 Cooperation in Alliances

## 3.2 Evidence of Complementarity

## 3.3 Assessment of the Complementarity Prediction

# 4 Conclusion

## 4.1 Overall Development

## 4.2 Future Research

# Appendix

## Visual Summary of Prior Results

	Substitutes	Complements	Null
Most and Siverson (1987)			X
Morrow (1993)	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 2: General Findings of Association Between Alliance Membership and Military Spending

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