Theoretical and Statistical Appendix to "Arms Sales versus Alliances: Trouble in Paradise"

1 Introduction

This appendix for "Trouble in Paradise: Arms Sales vs. Alliances" provides several theoretical clarifications and statistical robustness tests not included in the main document. These are:

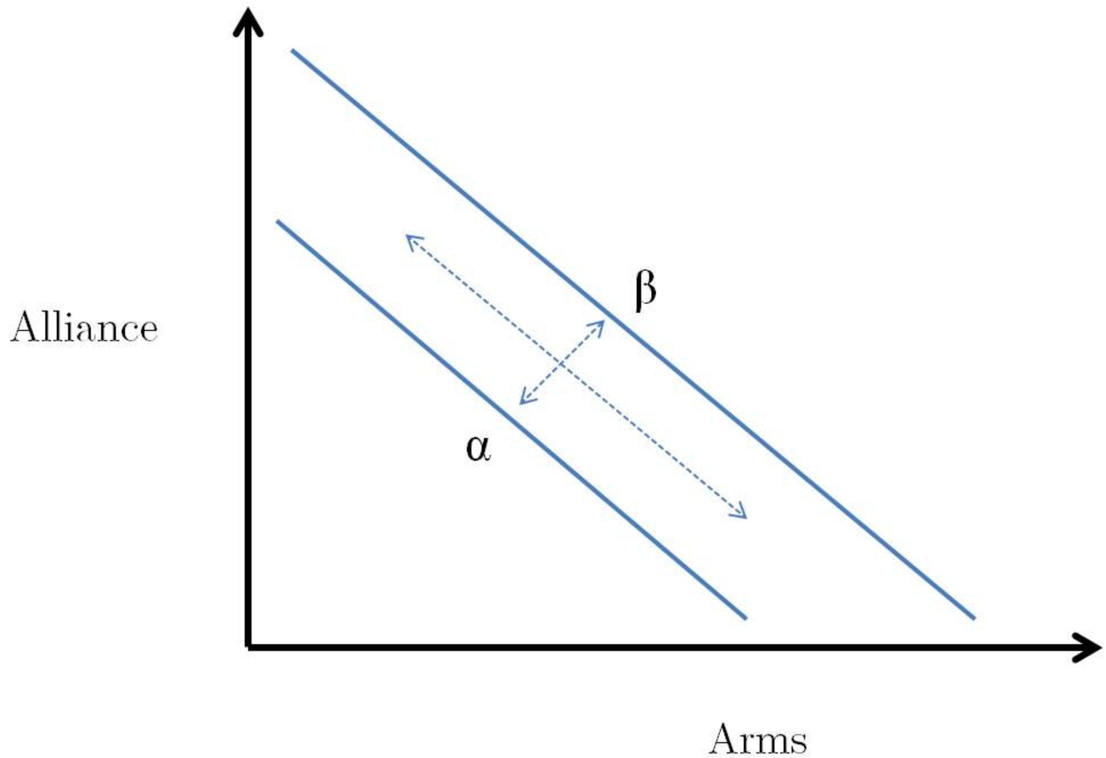
- Theoretical Clarification: Arms *and* Allies
- Theoretical Clarification: Going from Arms to Allies
- Descriptive Statistics
- Additional Statistical Test: Conflict Onset
- Additional Statistical Test: U.S. Troop Presence

2 Theoretical Clarification: Arms *and* Allies

The substitutive theory assumes that allies pay the minimum cost necessary to generate sufficient security against a common adversary. In essence, in forming a military pact, states automatically set the arms-ally curve at its maximum given the cost constraint. But there is one scenario where a country provides both substantial arms and alliance guarantees, but it does not signal weakening commitment: When an alliance's aggregate cost does not generate sufficient security for its needs. In that case, states will provide both greater arms and defensive guarantees, treating them as additive, not substitutes. This aligns with the argument made in Horowitz, Poast and Stam (2015).

To illustrate this, consider Figure 1 below, which visualizes the substitutive approach. Each individual state faces a tradeoff in how it supports its security partner. It must accept sufficient costs such that its partner recognizes its defensive commitments as credible. Yet it wants to minimize this cost to avoid free-riding, prevent moral hazard, and reserve as much of its capabilities as possible for other challenges. Consequently, the tradeoff between "arms" and "allies" is an intra-allied bargain over burden-sharing and cost distribution. In Figure 1, each state has a range of acceptable values along Curve α, creating a zone of possible bargains. The curve's slope represents the "exchange rate" between arms and alliance commitments. The exact point on Curve α that the allies choose determines their mix of arms sales and security guarantees, while the area under the curve indicates the aggregate cost and therefore security gained by the allies.

Figure 1: Stylized Tradeoff between Arms and Allies.



When partners are below their cost constraint, they can push Curve α outward to Curve β, treating arms and alliances as additive and increasing both simultaneously. While this is an important class of cases, they may be rare and may not constitute a significant challenge to the substitutive theory. First, states are likely to avoid weak (or "insufficiently strong") partnerships. They invite attack. Partners are more likely to abandon allies who only present liabilities for their foreign policy goals. States uncertain of outside support are unlikely to antagonize adversaries. Georgia is a clear, recent example of what happens when states ignore these dynamics. As Lanoszka (2018) discusses, Tblisi may have assumed it possessed stronger security support from the U.S. and Europe than it actually possessed, leading to a costly defeat by Russia. Similarly, the Korean War disabused American diplomats of the belief that the USSR posed only a medium-term political – and not military – threat, quickly spurring alliance creation in Europe, Asia, and the Middle East during the mid-1950s.

Second, even when pushing out the security curve, allies bargain over cost distribution. For example, the U.S. conducted concurrent negotiations with Western Europe over a defense guarantee (the North Atlantic Treaty, or NAT) and arms transfers (the Mutual Defense Assistance Program, or MDAP). Washington linked MDAP funding to acceptance of the "self-help" principle in the NAT, demanding that Western Europe first create its own defensive organization to demonstrate its seriousness about its own security. This process, the Americans hoped, would also consolidate European requests of U.S. materiel, forcing, say, France and the UK to bargain and prioritize needs among themselves first. Only after Europe settled on a final, collective amount of equipment would the U.S. negotiate. This strategy would restrain a "race to the top" dynamic where each partner made maximal, escalating, and often overlapping demands on U.S. resources. However, even after six nations acquiesced and created the the Western Union Defence Organization (WUDO), Washington continued to avoid steps that would impose security burdens on itself. For example, it preferred to merely associate itself with WUDO, rather than becoming a full member.[1] Similarly, Washington expected that equipment left by U.S. troops departing Europe would constitute a significant portion of MDAP transfers, further reducing its immediate costs. Consequently, even in situations where arms and allies add to aggregate se-

[1] George Kennan claimed, "People in Europe should not bother themselves too much in the initial stage [of a trans-Atlantic security partnership] about our relationship to this concept. If they develop it and make it work, there will be no real question as to our long-term relationship to it, even with respect to the military guarantee. This will flow logically from the consequences." (Kennan, 1947)

curity, states still follow a substitutive logic, attempting to distribute costs to their partners.

3 Theoretical Clarification: Going from Arms to Allies?

The theory focuses on burden-shifting in one direction: substituting arms sales for security guarantees. It does not analyze the opposite direction, where a state increases its alliance commitments and reduces arms sales. This is because such transitions are empirically rare.

Based on the main text's dataset, only 28 dyads had arms sales that predated an alliance commitment by more than five years. Of these, 20 follow a domestic political or system shift (e.g. a coup, the end of the Cold War, etc.). In effect, states are negotiating a entirely new security relationship, calling into question whether these cases represent a true transition from arms to alliances. Of the remaining eight dyads, seven acceded to treaties that only contained non-aggression provisions. Leeds et al. (2002) consider these a special category, since they do not obligate military action by members. Similarly, the main paper explicitly excludes this category from analysis, since there is no obligation nor burden-shifting occurring.

The only pair in the dataset that sees a clear "arms to alliance" shift is Libya-Malta. The two countries shared close security relations upon the latter's independence in 1964, with Libya providing helicopters and anti-tank weapons. They formalized their security partnership in a 1984 defense and neutrality pact, where Libya also promised to further train and arm the Maltese military. The pact was short-lived however, with Malta letting it expire after only five years in order to improve relations with Europe and NATO powers. Indeed, the Maltese ordered a variety of training and maritime patrol aircraft from the U.S. and UK throughout the 1990s.

With only one genuine case, the "arms to ally" shift should not require its own theory. However, the paucity of cases raises a broader question: Why do states only shift from alliances to arms sales? Conceptually, states appear to "fill up" their quotient of alliance ties, then, if necessarily, ratchet them down. One possible explanation is that major shifts in international order or domestic politics open narrow windows for countries to reconfigure their security relations. Once those windows close, however, it is difficult to create new alliances, possibly because they would negatively affect the rank and prioritization of existing security partnerships.[2] Overall, this question lies beyond the scope of the current paper, but its implications should not affect the main empirical tests.

4 Descriptive Statistics

Table I provides descriptive statistics for the main paper's variables.

[2]Kuo (2019); Krebs and Spindel (2018).

Variable	*N*	*Mean*	*SD*	*Median*	*Min*	*Max*	*Skew*
Onset	388515	0	0.06	0	0	1	16.37
Partner	388515	0.01	0.12	0	0	4	13.45
Minor-Minor	388515	0.9	0.29	1	0	1	-2.74
CINC	388515	0.02	0.03	0.01	0	0.49	4.18
Contiguity	388515	5.65	1.31	6	0	6	-3.7
Ally	388515	0.21	0.6	0	0	7	2.98
Sale	388515	0.06	0.62	0	0	31	20.85
Trade	388515	246.92	3341.35	0.99	0	398258.8	52.95
Rival	388515	0.03	0.19	0	0	8	7.78
Joint Democracy	388515	0.49	0.5	0	0	1	0.05
Term	388515	0	0.03	0	0	3	48.53
Troop	388515	2675.15	13414.4	11	0	326863	10.97

Table I: Descriptive Statistics for Model Variables.

5 Additional Quantitative Test: Conflict Onset

The main text focuses on partnering in interstate conflict, using a two-stage model to partial out factors that generate that conflict. But the substitutive approach also implies that states avoid initiating disputes when they receive weapons from their allies. This contrasts with the additive approach, where arms and allies signal increased support and raise the likelihood of conflict onset. Consequently, we can test the following hypothesis:

Hypothesis A1 In combination, arms transfers and alliance guarantees do not reduce the onset of interstate conflict.

I define *Onset* as a dummy variable which takes a value of "1" if either dyad member initiates a militarized interstate dispute. This variable is drawn from the Correlates of War Militarized Interstate Disputes dataset.[3] The theory expects *Sale::Ally*

[3] Palmer et al. (2015).

not to possess a statistically significant relationship with *Onset*, although the sign should be negative. As seen in the case study, although withdrawing its support, a state seeks to ensure that the common adversary does not attack during the transition process. The explanatory and control variables are carried over from the main text, and I use logistic regression.

Table II presents the results of four statistical tests. Model 1 contradicts the theory and supports the additive approach. *Sale::Ally* systematically reduces the likelihood a security partner initiates conflict. *Sale* also has a negative and significant sign, while *Ally* is positive but insignificant, in line with Braithwaite and Lemke (2011).

However, the additive approach, as its name suggests, treats the arms-ally category as simply the aggregation of an arms dynamic and a separate ally dynamic. In Yarhi-Milo, Lanoszka and Cooper (2016), for example, the local military balance drives arms transfers; the patron-client alignment of interests drives security guarantees; and states receive arms and alliances when those two factors converge. The substitutive theory, by contrast, argues that arms and allies interact in an unexpected way, exacerbating the alliance security dilemma. Rather than the convergence of two independent causal mechanisms, arms-allies is a separate conceptual category driven by its own internal logic.

To account for this, I use a matching algorithm. By its very nature, observational data prevents random assignment to treatment and control categories, leading to "unbalanced" samples possibly correlated along a number of observed and unobserved variables. Selection into arms-allies, as opposed to arms or allies alone, would certainly unbalance the data and confound estimates. I therefore use nearest neigh-

	Model 1 Standard Logit	Model 2 Matched Data	Model 3 Rare Events Logit	Model 4 Spatial Logit
Intercept	−5.47*	−3.48*	−2.92*	−3.14*
	(0.25)	(1.21)	(1.21)	(1.47)
Sale::Ally	−0.12*	−0.04	−0.04	−0.04
	(0.06)	(0.06)	(0.05)	(0.07)
Sale	−0.42*	−0.20*	−0.18*	−0.24
	(0.07)	(0.09)	(0.08)	(0.14)
Ally	0.02	−0.03	−0.02	−0.15
	(0.03)	(0.15)	(0.15)	(0.14)
CINC	10.60*	5.60*	5.24*	4.28*
	(0.63)	(2.32)	(2.32)	(2.03)
Minor Power	−0.61*	−0.39	−.36	−0.38
	(0.10)	(0.46)	(0.46)	(0.44)
Rival	0.88*	0.27	0.26	0.24
	(0.05)	(0.16)	(0.16)	(0.17)
Contiguity	3.64*	1.10*	1.07*	0.98*
	(0.07)	(0.31)	(0.31)	(0.29)
Trade	1.91×10^{-6}	8.08×10^{-6}*	8.19×10^{-6}	4.72×10^{-6}
	(2.48×10^{-6})	(3.65×10^{-6})	(3.65×10^{-6})	(3.41×10^{-6})
Joint Democracy	−0.03	−0.97*	−0.96*	−0.89*
	(0.06)	(0.33)	(0.33)	(0.39)
ρ				0.14
				(0.34)
N	388515	4855	4855	
AIC	14188.47	699.52	699.52	

* indicates significance at $p < 0.05$

Table II: Main results for the effects of arms sales, alliances, and their interaction on conflict onset.

bor matching (with replacement) to match observations where *Sale::Ally* equals 1 with those where it equals 0, comparing arms-ally dyads to their closest non-arms-ally counterparts. Under common support, does *Sale::Ally* still systematically reduce *Onset*?

Model 2 suggests not. Once we correct for imbalances in the data, treating arms-ally as a separate category, *Sale::Ally* is statistically insignificant, although still negative. Moreover, as in the main text, conflict onset is a rare-event. I therefore apply a rare-events logit, which returns the same result in Model 3. Finally, the distribution of arms transfers and alliance commitments is not uniform across states. Particularly powerful countries are disproportionately likely to provide one or both to their counterparts. The observational data cannot account for interdependencies and spillover across units. In correcting this, perhaps *Sale::Ally* can recover statistical significance. In Model 4, I use spatial logit regression, and again, our key explanatory variable is insignificant. In fact, across Models 2-4, *Sale::Ally*'s p-values increase. As we correct for additional sources of estimation bias, the relationship between *Sale::Ally* and *Onset* weakens, supporting Hypothesis A1.

6 Additional Quantitative Test: U.S. Troop Presence

The case study uses troop presence and withdrawal as an indication of security support, finding that Korea treated arms as a substitute for U.S. commitment. To what extent can that be generalized to other overseas deployments? While most countries either do not have troops overseas or do not make such data available, the U.S. fortunately does. Kane (2004) compiled the U.S. Department of Defense's "Deployment of Military Personnel by Country" data, which I use to define *Troop*, the number of American service personnel deployed outside the U.S. This serves as our new dependent variable, and I only keep dyads where the U.S. is present. As count data, I use negative binomial regression to test the following hypothesis:

Hypothesis A2 In combination, arms transfers and alliance guarantees decrease U.S. troop deployments in the recipient state.

Table III presents the results. Model 1 folds all the data into a single-stage regression. Model 2 uses a two-stage approach on the logic that troops are disproportionately deployed to those countries that have or are currently engaged in conflicts. It therefore "partials out" the factors causing conflict onset, as in the main text models and for Hypothesis A1. In either case, *Sale::Ally* systematically reduces U.S. troop presence, in line with this section's hypothesis.

Interestingly, *Sale* on its own has a positive and significant relationship with *Troop*. This might imply that the theory's microfoundations are incorrect. Simply receiving weapons increases the likelihood that U.S. troops will be deployed to your country. Insofar as troop deployments shift security burdens to the sender, we should not treat arms and allies (in this case encompassing troop deployments and security guarantees) as substitutes.

But examining the high-leverage/low-residual observations suggests that this is concern may be overblown. For non-allied, U.S. weapons recipients (748 observations), the residuals on Model 2 range from -1 to 281.99. Of the 46 observations with

	Model 1 Single Stage	Model 2 Two-Stage
Intercept	1.90*	2.47*
	(0.10)	(0.11)
Sale::Ally	−0.08*	−0.09*
	(0.01)	(0.01)
Sale	0.39*	0.47*
	(0.02)	(0.02)
Ally	1.05*	0.84*
	(0.04)	(0.04)
CINC	14.38*	14.64*
	(0.58)	(0.60)
Trade	0.00*	0.00*
	(0.00)	(0.00)
Rival	0.47*	
	(0.07)	
Contiguity	−0.67*	
	(0.27)	
MID	1.77*	
	(0.08)	
N	7374	7374
AIC	75980.53	76703.96
BIC	76256.76	76924.94
$\log L$	−37950.26	−38319.98

* indicates significance at $p < 0.05$

Table III: Main results for the effects of arms sales, alliances, and their interaction on U.S. troop presence.

residuals between (-0.5, 0.5), 38 are in the Middle East, with Saudi Arabia, Egypt, and Bahrain constituting 15, 9, and 8 observations, respectively. While Washington has close security relations with each of these states, it is not clear that U.S. troops are meant to specifically or even primarily defend these countries. The Egyptian observations had fewer 116 troops on average serving primarily in an advising capacity. Even the Saudi observations had just over 259 troops on average, in part to coordinate military operations against Iraq and Iran. Hosting the U.S. Fifth Fleet, Bahrain had the most American troops deployed at 2184 on average. Yet, the U.S. did not publicly intervene when Saudi Arabian troops entered and forcibly suppressed Bahraini protests through the 1990s and in 2011.

By contrast, between 1991and 1995, American troops were explicitly present in Kuwait to defend the country. Yet, the residuals on these observations are much higher, in some cases an order of magnitude more than the 46 observations mentioned above. Similarly, during the Korean War, the 1951 and 1952 South Korea observations had the second and third highest residuals (58.52 and 104.49, respectively). In combination, this suggests that the observations driving the result on *Sale* most align with the theory. In those cases, American troops are not deployed to defend their host. Those observations where U.S. forces explicitly defend the host country are among those that are hardest for the model to fit.

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