A Division of Defense Labor Across Nations*

A Theory of the Shared Production of Military Capabilities

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Theories of alliance burden-sharing have primarily investigated the size of allied state militaries, but not their composition. Why do some alliance partners engage in a division of labor over the security capabilities they produce, while other alliance relationships maintain redundant militaries with overlapping capabilities? I argue that alliance relationships can promote an efficient division of labor over the production of defense assets when that alliance relationship has high strategic compatibility and is hierarchical. These two conditions make it easier for states to minimize the risk of defection and ensure effective coordination in a manner that allows them to distribute defense capabilities efficiently across actors. In doing so, states in military alliances can coordinate their defense in a way that garners the benefits of individual specialization and collective diversification. I substantive this argument using data on disaggregated national military capabilities from 1970 – 2014.

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1 Introduction

Why do some alliances have members with militaries that complement each others' military capabilities, while other alliances are made up of states with more redundant militaries? The institutional form of interstate cooperation helps explain functional differentiation as a conscious policy choice by actors that rely on each other for security. Allied states can engage in division of labor over the production of defense assets – each excelling in distinct and complementary capabilities – when their relationship is characterized by high strategic compatibility and hierarchy that they expect to continue into the future. This explains variation in the distribution of military capabilities across states not simply as a product of economic capacity and geography, but also as a function of states' willingness and ability to omit and/or overproduce some defense capabilities based on the capabilities of their partners. This builds upon existing theories about the conditions under which major states try to gain security through joint efforts (Jervis 1986, 58). I examine the consequences of those joints efforts and add a nuanced understanding to what it means to be 'joint'.

This paper is organized into five sections. Section 2 outlines existing thinking concerning the degree to which states exist in an anarchic world of 'self-help' concerning defense. Section 3 then details a theory of a shared production model of defense outlining the conditions under which cooperation under anarchy enables functional differentiation in the production of security – strategic compatibility and hierarchy. In doing so, it develops a typology that explains the various forms of security cooperation and state military capabilities that should exist based on these two conditions. Section 4 provides an empirical test of that theory by identifying the division of labor in security capabilities across all states from 1970 – 2014 using a novel dataset of disaggregated military capabilities. Section 5 concludes with the implications of these findings for theories about international cooperation and conflict and avenues for future research.

2 Existing explanations for cooperative security

There are numerous existing explanations for the composition of a state's military, ranging from economic and geographic considerations (Brooks 2005) to domestic politics (Allison and Morris 1975; Kehr 1975) to social considerations and status (Spinardi 1990; Eyre and Suchman 1996). The prevailing political explanation concerns the nature of the international threat environment (McNamara 1967; Rathjens 1969; Berman and Baker 1982). So why do some capable countries have gaps in their militaries that they could fill, but choose not to, while other capable countries appear dissatisfied with those gaps? This functional differentiation is not just the product of the distribution of power and it does not appear that states are trying to be self-sufficient in their defense (Mawdsley 2018, 260), as some scholars have predicted (Bitzinger 2017).

If the international system is anarchic and governed only by the logic of self-help, then states can deal with that threat environment through either internal or external balancing (Waltz 1979; Mearsheimer 2001). The logic of internal balancing means states provide for their own security by arming themselves while external balancing means cooperating with allies against the overarching threat. A result of internal balancing is that state militaries start to look similar overtime as states mimic the capabilities of greater powers, with differences explained by the distribution of resources or geography (Parent and Rosato 2015). External balancing, when it happens at all, does not change the composition of military capabilities each states possesses because of concerns that cooperation cannot be guaranteed. And in the event that State A and B do cooperate, the stronger of the two will be able to impose its will and preferences over the other rather than engaging in a "division of labor across nations" (Waltz 1979, 105) since self-interested states have no incentive to provide for the security of another state absent that provision enhancing its own security.

Opposition to this neorealist view of anarchy has come from the hierarchic view of international politics. If State A and B faced a similar threat environment because of State C, State A and B should engage in a division of labor over the production of security assets to most efficiently provide for their collective security (Lake 1999). They have everything to gain and very little to lose from that cooperation (Axelrod and Keohane 1985). The problem with the previous perspective is thinking about power as a component of competition that all states are engaged in without consideration of the cost of fighting. In reality there are bystanders who gain or lose based on the outcome of competition between two states and the cost of competition can shape whether the gains of competition are worthwhile. While quoted above in recognizing the best defense against an unpredictable enemy is diversified combined arms, Till (1994, 185) also noted that it may be "necessary to augment these by improving access to the capacities of the other services, and of friendly navies."

And yet, while proponents of this theory would predict a division of labor in defense among like-minded states, the empirical record is far from set. To take Europe as an example, while "one might expect a continent with both a long-established military alliance and highly integrated economies and policymaking machineries to also have a highly integrated defense economy" (Mawdsley 2018), others have found that Europe's defense market is actually quite fragmented and protectionist (Bitzinger 2009). The 27 states in the EU have a combined 25 armies, 21 air forces, and 18 navies most of which possess different weapons systems and that rarely coordinate force planning (Howorth 2007). This is not a new problem either; not long after the end of the Cold War (De Vestel 1995) noted that the redundancy of Europe's defense platforms was becoming increasingly costly. This duplication was not inevitable and could have been ameliorated through pooling and sharing agreements.

So the question becomes why we see a division of labor in some cases but not others and, more interestingly, the form that this division of labor takes. If states facing a common threat

feel they are in the world of anarchy, they will have diversified military capabilities since mistrust results in "self-help" defense. But if states facing a common threat have some reason to believe they can effectively cooperate despite anarchy, they will engage in a division of labor through complementary military capabilities since mechanisms for fostering that cooperation enable them to "provide for the common defense". Because my theory borrows generously from this perspective, a comprehensive account of existing research is embedded into the following theory.

3 Theory: Bringing balance to each other's force

What are the conditions under which two allies are able to ensure that a promise to cooperate with each other in the development and deployment of military capabilities happens successfully? Generally speaking, alliances are a promise to cooperate with another actor under a given set of contingencies (Papayoanou 1997). Research on bargaining within alliances has started from the Ricardo (1817) model of comparative advantage in trading goods based on differences in production costs (Snyder and Diesing 1977; Snyder 1984, 1997; Morrow 1993). One of the things states in an alliance bargain over is which produces what capabilities because these capabilities differ in their asset specificity, economies of scale (private benefits), and contribution to aggregated defense (public benefits). In the context of military capabilities, a complementary division of labor with an ally can thus be an efficient way to undertake defense cooperation, but it requires bargaining over the terms of that cooperation.

3.1 Barriers to cooperation under anarchy

A state's decision about whether to cooperate with other states over the ownership and use of security assets is a function of three factors - the gains from cooperation, the expected cost of

opportunism, and the expected cost of coordination (Lake 1997).[1]

The gains from cooperation include economic benefits from economies of scale, political benefits from the efficiency gains of focusing on core competencies, and security benefits from improved performance at particular security needs (Gannon 2023). After all, one of the expected payoffs from developing relationships with strategically compatible states is the expectation that some aspect of your ally's military resources are available during war (Olson and Zeckhauser 1966; Conybeare 1992). The expected cost of opportunism is a function of the severity and likelihood of abandonment, entrapment, and exploitation (Snyder 1984). The expected cost of coordination concerns how much work is required to ensure the relationship achieves the expected benefits (Gulati and Singh 1998).

Concerning the risk of opportunism, both states must feel that mutual cooperation is preferred to mutual defection in cases where unilateral defection is preferred to unrequited cooperation (Axelrod and Keohane 1985; Oye 1985). Otherwise, relying on another state that may renege when asked to contribute to your defense could seriously jeopardize a state's security (Dekker 2004). If this risk is seen as high, states should instead opt to produce security on their own. Opportunism via abandonment (shirking or buck-passing), entrapment (chain ganging), or exploitation can prove fatal to a state that depends on another for defense (Snyder 1984), especially if that dependence took the form of a specialization via omitting necessary defense assets. Avoiding this requires avenues for communication and routines for interaction that mitigate concerns about opportunism sufficient to encourage coordinated military strategies (Ikenberry 2001). Because relying on your partner to provide assets risks losing autonomy over the conduct of those assets during combat, there can be ambiguity about the effects of cooperation on a state's security goals (Morrow 1991). As Auerswald and Saideman (2014,

[1]While I here focus on defense pacts, there is an extensive body of research concerning different forms of defense cooperation and security alignments (Lake 1996; Weber 1997, 2000; Haftendorn, Keohane, and Wallender 1999; Leeds et al. 2002; Benson 2012; Wilkins 2012).

232) put it, "in alliance warfare, allies sometimes do not always show up when needed or they show up but are not able to do what is needed."

The costs of coordination are distinct from those incurred from opportunism (White 2005, 1385). While opportunism costs focus on uncertainty regarding your partner, coordination costs are about uncertainty regarding the task (Oxley 1997). You can have full confidence your partner will not act opportunistically if strategic compatibility is perfect given identical interests, but there still has to be coordination about who is specializing in what and a formal designation of roles. Despite this, international relations research on the problems of cooperation inspired by Williamson (1985) and the accompanying transaction cost framework have been less concerned with coordination costs, instead arguing that opportunism costs should be at the forefront (Lake 1996). Coordination costs may not be particularly salient in contexts where resources are simply pooled, but that is not the case in the security context (Overhage 2013). It is quite difficult to fight a war with another state's tools. In defense, "duplication of facilities, differences in requirements, coordination problems, lack of clear control and delays due to different budgetary systems all tend to increase the costs of collaborative projects" (Smith 1996, 69–70). Collaboration requires communication, making adjustment in response to your partners actions. This is fundamentally an issue of information asymmetry, so creating a "common knowledge assumption" can induce and stabilize cooperation by reducing uncertainty about the other actor's payoffs structure and conveying one's own payoff structure to your partner (Gulati and Nohria 1992, 19).

My central argument follows: intra-alliance bargaining can more easily reduce the risk of opportunism and costs of coordination costs when (1) there is high strategic compatibility, meaning members have consistent security interests (Papayoanou 1997; Poast 2019) and (2) the alliance in hierarchic, allowing a small number of participants to dictate the terms of the bargain (Krasner 1991; Lake 2001). Under these conditions, states are able to produce com-

plementary militaries in ways that garner the efficiency gains of specialized production while maintaining the security gains of a diversified defense portfolio. If intra-alliance bargaining does not succeed because a gap in strategic compatibility has narrowed the bargaining range and/or because one actor cannot dictate the terms of the bargain sufficient to reach a mutually agreeable solution, then there will not be a shared division of labor over the production of security and states will thus design defense portfolios that rely less on the capabilities of others and are thus more redundant and self-reliant. Sections Section 3.2 and Section 3.3 detail these two factors.

3.2 Theorizing strategic compatibility

I define strategic compatibility as the consistency of states' security interests and degree to which they agree on the nature of the possible international threat environment (Poast 2019, 5). Whether states have common security interests is a function of whether they face the same threats and the mutual desirability of ways to deal with that security threat. When security interests between two states are consistent, an adversary that poses a threat to one state's security interests also poses a threat to the other state's security interests and the salience of states that are a threat to only one of those two states is small (Yarhi-Milo, Lanoszka, and Cooper 2016). In this situation, states are more likely to have compatible payoff structures regarding behavior conducive to the creation or maintenance of the optimal international environment (Axelrod and Keohane 1985).

For strategic compatibility to incentivize security cooperation, and thus encourage a division of defense labor, it must increase the gains of cooperation and reduce its costs (opportunism and coordination costs). Strategic compatibility improves the gains of cooperation by augmenting the effectiveness of coalition contributions to war (Stueck 1997; Kreps 2011; McInnis 2019; Cappella Zielinski and Grauer 2020). Snyder (1997, 166) writes that "among the most

prominent issues in intra-alliance bargaining are the coordination of military plans, the stance to be adopted toward the opponent in a diplomatic crisis, and the sharing of preparedness burdens in peacetime." Strategic compatibility make crisis bargaining within the coalition easier which improves that coalition's ability to credibly signal resolve. It also positively shapes that coalition's collective strategy in the event that conflict does break out (Wolford 2015). Cases of collective security are representative of cases of high strategic compatibility. When a state opts for collective security, they are essentially conveying that the security of the whole is an vital component of the security of the homeland (Conybeare and Sandler 1990).

Because it concerns a shared understanding of agreed upon security goals, strategic compatibility can be seen as a necessary condition for cooperation (Axelrod and Keohane 1985; Oye 1985). High strategic compatibility makes it easier to overcome opportunism and coordination costs because the presence of a common objective that both actors seek produces higher payoffs to conscious policy coordination (Oye 1985; Thies 2003; Wolford 2014). This is especially true in cases where the common threat facing two states is something like a territorially acquisitive great power since they both have an interest in mutually producing the capacity to respond to that threat. But despite being a necessary condition for cooperation, strategic compatibility is not a sufficient one. Circumstances where strategic interests are perfectly aligned seem exceedingly rare – if not non-existent – in international relations. And unless there is perfect harmony in strategic compatibility, the risk of opportunism can only be reduced, not eliminated, as long as each actor retains autonomy over its own decision-making (Gulati, Wohlgezogen, and Zhelyazkov 2012).

For example, the US relationship with Australia took a significant turn in the early 1970s when Nixon's Guam Doctrine announced US withdrawal from Asia and an expectation that its allies in the region do more to defend themselves (Curran 2014). Australia's concern about the US retreat from Asia after the Vietnam War was pronounced and marked the beginning

of a new Australian perspective that they were alone in their defense since their strategic interests were no longer highly compatible with that of the United States. The Defence White Paper (1976) noted "it is not our policy, nor would it be prudent, to rely upon US combat help in all circumstances". As a result, high strategic compatibility mean states will contribute to the security of their ally because they have a security incentive to do so even in the event that their partner may defect.

By increasing the expected gains of cooperation and overcoming the expected costs of opportunism and coordination, high strategic compatibility can increase states' willingness to embrace a shared production model of military capabilities. By complementing each other's forces, the gains from economies of scale mean that each state is better off than if they simply added their redundant military capabilities together. The gains from specialization can now be realized if the accompanying costs have been sufficiently reduced by high strategic compatibility. Importantly, the rewards of shared production can be reaped internally. Since reducing the production of particular capabilities is one manifestation of specialization, states benefit economically from sharing the burden.

Hypothesis: Defense alliances with high strategic compatibility should have a higher division of labor than alliances without high strategic compatibility.

Of course, this relationship is endogeneous – a state's relationship with other states influences the capabilities each state produces but the capabilities each state has at their disposal also impacts the decision to ally with another state (DiGiuseppe and Poast 2016). States may specialize because the omission or surplus production of particular capabilities creates the conditions for mutual vulnerability and interdependence as a form of hostage-taking (Williamson 1983). But rather than think of this endogeneity as a barrier to casual inference, it instead also explains why this relationship may be enduring. If a state has a demand for a particular military capability that is part of another state's military portfolio, and the first are unable to

make or buy that capability, it may strengthen its relationship with the other state so as to enhance the first's ability to borrow (Conybeare 1992). If this is true, then the nature of the alliance relationship is still influencing the types of capabilities states are producing. A small and vulnerable state would strategically maintain dependence on a powerful ally by specializing its own military in a way that ensures the powerful ally maintains that relationship.

3.3 Theorizing hierarchy

I define hierarchy as a community with an asymmetric distribution of influence where a small number of dominant actors authoritatively control the behavior and characteristics of a larger number of subordinate actors when it comes to international security (Zaheer and Venkatraman 1995; Donnelly 2006).[2] In contrast to its early conceptualization in international politics, hierarchy is a relational attribute of a community; a network of actors has some observable degree of hierarchy defined by the nature of their relationships (MacDonald 2018).[3] Influence within the network is asymmetric in that decisions about self-enforcement are controlled by one or a few dominant actors which contrasts with non-hierarchical communities where arrangements about defense efforts are largely self-enforcing (Jung and Lake 2011). Authoritative control means that the dominant state(s) exerts influence over the decisions of other states with varying degrees of consent and/or coercion, although the means used do not determine if a community is hierarchical.[4]

While hierarchy involves power imbalances and structures of control and decision-making, it is not strictly synonymous with either of these concepts (Lake 1997). While some hierarchical re-

[2] I scope my analysis to hierarchies concerning security. For hierarchies in trade, see Manger, Pickup, and Snijders (2012).

[3] Especially concerning empirical identification and measurement, only recently has work on hierarchies in international politics shifted its level of analysis from the dyad (Lake 2009; Jung and Lake 2011) to network (Beardsley et al. 2020; Kinne and Kang 2023).

[4] For contrasting views on the role of consent and coercion in hierarchy, see Holsti, Hopmann, and Sullivan (1985), Lake (1996), Hobson and Sharman (2005), Lake (2007), Lanoszka (2013), Mattern and Zarakol (2016, 632), and MacDonald (2018).

lationships have an unequal distribution of material military power such that "a more powerful state has the material capability to intervene in and provide security for the weaker one" the presence of such a capability is not synonymous with hierarchy nor is its absence indicative of a horizontal relationship (Wendt and Friedheim 1995, 696). Such a perspective does not give appropriate agency to the actors whose decisions create these relationships, which is especially important when thinking about hierarchy as complex networks involving multiple overlapping ties between actors (Onuf 1989, 2013). Similarly, hierarchy can create formal institutions of cooperation, but does not need to. Centralizing decision-making is distinct from formalizing it, and in fact dominant states may avoid formalizing cooperation within institutions because reasons TBD (cite TBD).

Hierarchy increases the relative gains of cooperation by reducing the risk of opportunism and the cost of coordination. It reduces the risk of opportunism through three mechanisms; solving information asymmetries, increasing reputation costs, and creating mutual interdependence. The first of these, information asymmetries, are resolved by hierarchy by providing rules of thumb concerning the role each state plays in the relationship (Oye 1985). The dominant state delegates nodes of responsibility to the subordinate state either because those tasks are less important niche capabilities or because the subordinate state can perform those tasks at a lower cost given comparative advantage offered by geography or industrial capacity (Sugiyama and Sugawara 2017). This can reduce uncertainty about its costs because you have some idea of how they will act in turn. When that happens in both directions, there is confidence they won't act opportunistically (Axelrod 1984). By transferring a purely exchange relationship into a power relationship, hierarchy ensures unified command (Galbraith 1977; Gulati and Singh 1998). NATO did this by explicitly linking the stationing of US troops abroad in exchange for countries purchasing US military equipment (Axelrod and Keohane 1985).

Reputational costs matter for cooperation because actors are almost always in mutual over-

lapping alliances or have an expectation of possible alliances in the future (Gulati and Nohria 1992, 19). If international cooperation is a game of repeated play, then actors have to demonstrate that they are worthwhile partners (Tomz 2007). Hierarchy increases reputational costs by centralizing decisions about issue linkage and creating precision in how cooperation will happen (Abbott and Snidal 2000; Koremenos, Lipson, and Snidal 2001; Mattes 2012). This reduces the risk of opportunism by creating exit costs to reneging on cooperation (Weber 1997) which also facilitates reciprocity and further cooperation (Gulati 1995; Malhotra and Murnighan 2002; Mellewigt, Madhok, and Weibel 2007). By making reciprocity more likely, we now have a necessary condition for states to believe that mutual cooperation has higher payoffs than mutual defection (Keohane 1986).

Lastly, even in asymmetrical alliances where the strong state is determining the terms of the agreement, both states are able to leverage the power of their allies to achieve international outcomes that are in their favor (Davidson 2011). Smaller states may desire institutionalizing their relationship with more dominant states precisely because that increases their bargaining leverage and creates mutual interdependence (Bosse and Alvarez 2010; Schneider 2011). This provides a way for both actors in an alliance to value the alliance independent of the degree of control they exercise in determining the structure and terms of that alliance (Schroeder 2004; Weitsman 2004; Bearce, Flanagan, and Floros 2006).

Hierarchy also reduces the cost of coordination because it improves information processing (Chandler 1977; Gulati, Wohlgezogen, and Zhelyazkov 2012), ensures actors know what communication is authoritative (Galbraith 1977), and simplifies decision-making (Chandler 1977). "The focus shifts to creating structures, institutions, and relationships that enable partners to work together across boundaries. The coordination perspective emphasizes organization design, communication, and process management as requisite skills of alliance managers"(Gulati, Wohlgezogen, and Zhelyazkov 2012, 533). This helps produce things like standard operating

procedures (SOP), unified command structures, and authoritative rules and procedures that create the type of task coordination that is needed for certain military strategies and structures (March and Simon 1958). These help minimize communication, simplify decision-making, reduce uncertainty about future tasks, and prevent disputes (Pondy 1977). By reducing the costs of coordination, institutionalization makes the interdependence of tasks easier which, in turn, facilitates a division of labor (Axelrod and Keohane 1985). Institutionalization allows actors to figure out the "anticipated organizational complexity of decomposing tasks among partners along with ongoing coordination of activities to be completed jointly or individually across organizational boundaries and the related extent of communication and decisions that would be necessary" (Gulati and Singh 1998, 304).

Hypothesis: More hierarchical defense alliances should have a higher division of labor than less hierarchical defense alliances.

I predict a low division of labor by states in alliances that have low strategic compatibility and that are non-hierarchical because the expected costs of opportunism and coordination exceed the expected gains of cooperation (Wendt and Friedheim 1995). In this situation, purposeful functionally differentiation across militaries in a way that creates dependence on other states leaves one vulnerable to costly and likely opportunistic behavior by others (Lake 1997). Instead, states occupying similar geographic and economic positions in the international system will adopt similar strategies for power and security.

4 Empirics

4.1 Dependent Variable

The dependent variable is the division of defense labor among allied states. I conceptualize security as an output that requires a number of distinct tasks (observed as military capabilities) that can, in theory, be distributed among a number of members of an alliance (Gorelick et al. 2004). This can be observed as a matrix where each row is an alliance member and each column is a functional security capability. Each cell represents the quantity of that technology owned by that alliance member. A division of labor can then be quantified as the degree to which each member of the alliance specializes in one activity or performs all tasks, whether a task is performed by one alliance member or many of them, and what activities are performed together by the same individual (Gorelick and Bertram 2007). I assume that these technologies could at least in theory be allocated to the defense of other allied states. When multiple allies possess the same military capabilities and omit the same military capabilities, their division of labor is low and can be described as redundant – neither is making a substantial unique contribution to their "pooled" defense capabilities. By comparison, when multiple allies possess different military capabilities from one another, they each fill in the gaps such that the combination of their capabilities is distinct from, and more well-rounded, than each individual state.

The division of labor between states in an alliance is calculated as their 'niche width' which measures the weighted pairwise similarity of their military portfolios in a given year (Bolnick et al. 2002). For each year t, considering an $n \times m$ matrix for every alliance member N and technology M. The pairwise similarity measure $\theta_{ij} = \sum_m min(p_{im}p_{jm})$ for every states i and j where p_{im} and p_{jm} represent their respective proportions of technology m (Zaccarelli, Bolnick, and Mancinelli 2013). The measure is normalized between 0 and 1 where 0 means the group of states have entire dissimilar militaries and 1 means they have the exact same technologies

in identical proportions. A division of labor can thus be observed as the complementarity associated with high dissimilarity since it means your partners possesses capabilities you do not and visa versa. Figure 1 illustrates the distribution of the division of labor scores in the data.

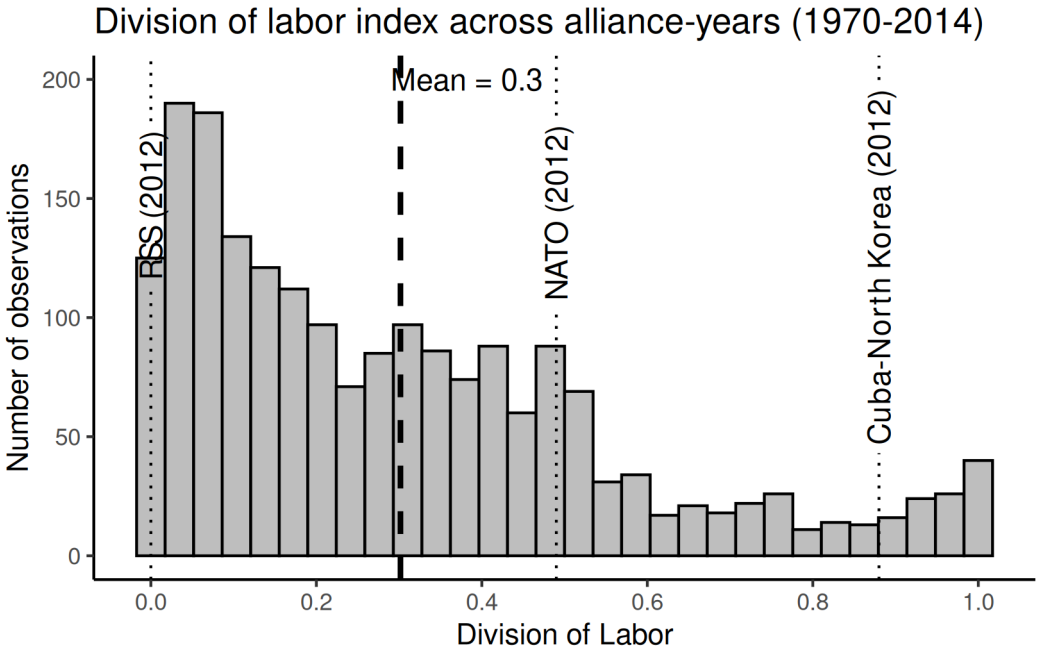


Figure 1: Distribution of alliance-year division of labor. The measure is bounded between 0 and 1, with 1 representing the highest theoretically possible level of division of labor.

The measure is weighted, meaning that their similarity is considered proportional to the size of each state (measured as the number of technologies it possesses) as well as the abundance of each technology. For example, two states both possessing 100 main battle tanks does not contribute very much to their similarity because main battle tanks are quite common. By contrast, the possess of ICBMs by two states would contribute much more to their similarity given the rarity of that capability. This measure is appropriate since it can account for actors that possess 0 of a given technology and was developed to account for wide differences in the availability of each technology.

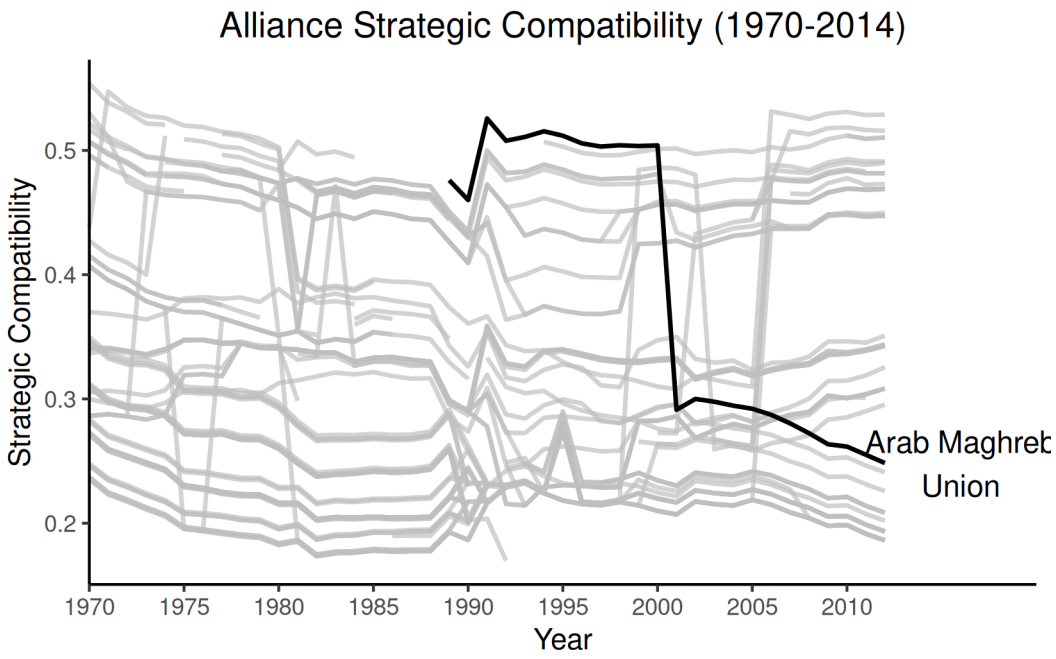
Cooperation between the US and European countries during the Iran-Iraq Tanker War worked because each was uniquely specialized in a way that produced complementarity rather than redundancy. The US provided large surface vessels that the other states did not have and the Netherlands and Belgium provided minesweepers that the US did not have. If the US and European countries had all been specialized in minesweepers, this cooperative security arrangement would not have made sense. As another example, while the US possesses only 2 Arctic-capable icebreakers (as opposed to Russia's 40), 7 of the 8 Arctic nations are US allies via NATO or NATO-partners (Markowitz 2020, 76–78). For example, Thule Air Base houses the US Ballistic Missile Early Warning System (BMEWS), yet winter access to the base by sea is provided entirely by Canada's icebreaking fleet (Cross 2019). By having a division of labor whereby US allies operate icebreakers in the Arctic, "allies and partners can free up U.S. time and resources to focus elsewhere. They can also help improve situational awareness and manage tensions more broadly to minimize dangers and create opportunities in and near the North American and European Arctic" (Avey 2019). These capabilities thus complement the technological omission of the United States.

4.2 Independent Variables and Controls

The explanatory variables concern variation in alliance relationships. I differentiate alliances using the two variables described earlier – strategic compatibility and hierarchy. The combination of the two variables provides both across- and within- alliance comparisons. Alliances with high strategic compatibility and high hierarchy should have the highest division of labor. I define these variables at the alliance level for the network of states that share a defensive alliance pact. Data on alliance pact membership comes from the Alliance Treaty and Provisions (ATOP) data set version 5 (Leeds et al. 2002).

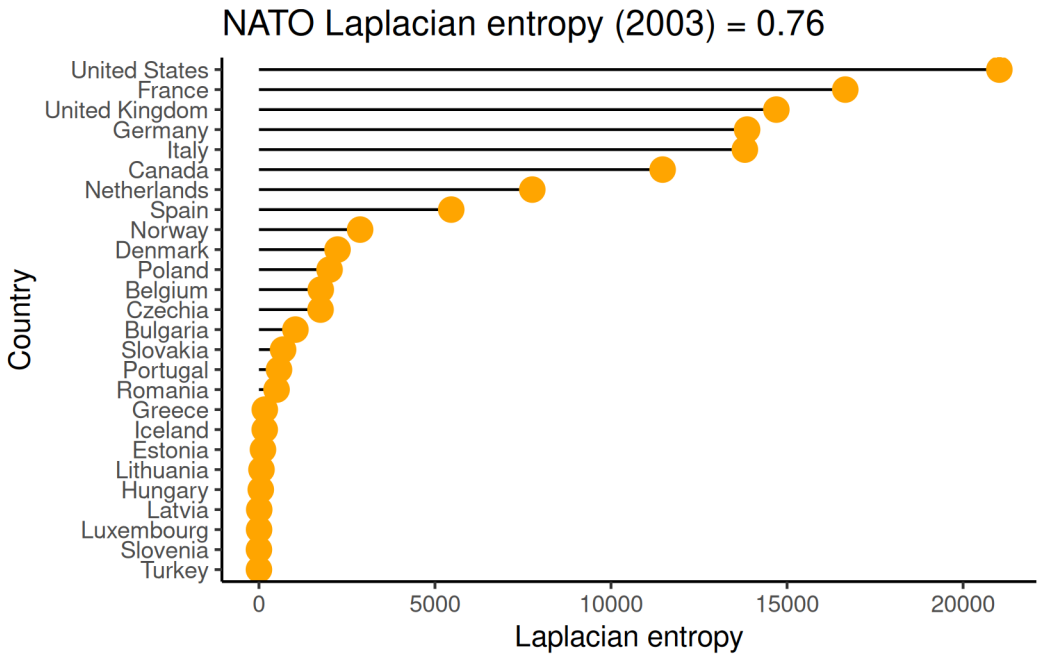
Strategic compatibility describes the consistency of two states' security interests and agreement

on the nature of the international threat environment. I create a new index of the strategic compatibility across alliance members is a given year based off of a similar measure used by Leeds and Savun (2007) and Poast (2019). I first create a measure of each country-year's threat environment, where threats are defined by a combination of power and foreign policy orientation. State B is considered a part of State A's threat environment if it meets any of the following conditions: (1) State B is a non-allied great power, (2) State B is a strategic rival, as defined by Thompson (2001) and Colaresi, Rasler, and Thompson (2008), or (3) State B is contiguous with State A and has an s-score that is below the population median (Leeds and Savun 2007). From this, I then identify the shared threat environment across alliance members in a given year, where the shared threat environment is defined as the ratio of summed CINC scores for common threats divided by all threats squared (Poast 2019, 55). The resulting index is thus highest for alliances where all members have the same threat environment and lowest for alliances where the common threat(s) the members face are much less militarily salient than the threats they each face individually. While formal alliances themselves may not often change rapidly or substantially, the salience of the threats that a particular alliance can reliably help counter does change.



Operationalizing hierarchy in international politics has been a notoriously challenging enterprise (MacDonald and Lake 2008). Recent methodological advancements have benefited from the turn towards network analysis in international relations which provides a better picture of true interstate relations than previous dyadic measures (Poast 2010, 2016; Dorff and Ward 2013; Cranmer and Desmarais 2016). Building off Beardsley et al. (2020)'s innovative measure of hierarchy as the network centrality of joint-production security communities, I consider the degree of influence that each state in an alliance network has on its security community, where influence is observed as relative dependency in directed arms sales. This accurately measures my conception of hierarchy by identifying the relationship between dominant states that "reside in central positions in networks of exchange" when exchange concerns the primary material tools of security (MacDonald 2018, 131). Using SIPRI arms sales data, I create a global network with weighted directed edges accounting for arms sales between each pair of states. Subsetting that to each alliance network, I then measure hierarchy as the difference in importance of each state within an alliance network. In an alliance network where all states

are equally important, the degree of hierarchy can be described as low. But if one state is highly influential in an alliance network, the degree of hierarchy is high because there is a relational power imbalance as a structural property of the network of states (Kahler 2009). The importance of each state is measured as the drop in the network's Laplacian energy when that vertex is removed, where Laplacian energy is quanitified as the sum of squares of the eigenvalues in the Laplacian matrix of arms sales (Qi et al. 2012; Boley, Buendia, and Golnari 2018; Cordeiro et al. 2018). This produces a Laplacian measure of importance/centrality for each state within an alliance. For each alliance year, I then take the mean between the highest Laplacian value and every other Laplacian value which creates a network-level measure of hierarchy. This measure has been previously used to identify central actors in terrorist networks, which validates it as an accurate measure of the relative importance of political actors (Qi et al. 2013).



The models include control variables for geography, economic capacity, and the threat environment since existing theories suggest that these factors could influence the degree to which two

states have a similar distribution of military capabilities or that could influence the degree to which those states cooperate on security issues. More militarily powerful alliances may have a different division of labor, the model includes a control for the squared total CINC score among all alliance members (Fordham and Poast 2016). The model also controls for the proportion of states in an alliance that are a democracy, measured as a Polity score greater or equal to 6, since democratic allies may trust each other to different degrees (Chiba, Johnson, and Leeds 2015). Since geographic proximity may better enable allied states to cooperate militarily, the model controls for the logged maximum distance between alliance members (Bak 2018) as well as the proportion of alliances members that are contiguous (Fordham and Poast 2016). Larger alliances may inherently have a lower division of labor since more partners increases the potential for overlap and redundancy in capabilities, so the model includes a control for the logged number of alliance members in a given year (Chiba, Johnson, and Leeds 2015). Established alliances are more likely to have deeper roots for cooperation and thus have an easier time cooperating, so the model controls for the average number of years each member has been in the alliance (Benson and Clinton 2016). The model also controls for time using cubic year polynomials, as changes in the quantities and qualities of technologies over time may impact the observed division of labor (Carter and Signorino 2010).

4.3 Model and Results

The dependent variable is the division of labor of military capabilities measured for each alliance-year. The dependent variable is continuous and bounded between 0-1 where 0 represents redundant militaries and 1 represents complementary militaries that constitute a division of labor. The models are estimated using a series of ordinary least squares (OLS) regressions with standard errors clustered at the alliance level.

Table 1 shows the results of a series of models, with varying specifications. I first estimate a

model using just the two explanatory variables of interest. Without control variables, strategic compatibility and hierarchy both have a statistically significant positive association. Model 3 considers both independent variables and finds similar results. The fully specified model (4) includes all control variables and produces similar results suggesting that strategic compatibility and hierarchy are positively associated with a higher division of labor. I do not interpret the model coefficients for any of the control variables, due to the absence of confounders for those variables (Dworschak 2023).

	(1)	(2)	(3)	(4)
Strategic Compatibility	0.763***		0.670***	0.678***
	(0.152)		(0.126)	(0.072)
Hierarchy		0.274***	0.240***	0.157***
		(0.051)	(0.048)	(0.048)
CINC sq.				0.445**
				(0.136)
Democracy Ratio				-0.043+
				(0.023)
Max distance (log)				0.038**
				(0.014)
Contiguity Ratio				0.088***
				(0.021)
Alliance Members (log)				-0.041***
				(0.012)
Alliance Age (avg)				0.003***
				(0.001)
Num.Obs.	1910	1996	1910	1893
R2				0.200

	(1)	(2)	(3)	(4)
R2 Adj.				0.178
AIC	3945.0	4117.9	3847.9	
BIC	14543.7	15282.1	14441.0	

Note: ^^ + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Note: [a] All models include country-clustered standard errors.

These results are robust to a series of alternate model specifications provided in the appendix. Further models operationalize strategic compatibility using other commonly used metrics like s-scores (Signorino and Ritter 1999; Leeds and Anac 2005) and joint alliances, as well as operationalizing hierarchy as signaled support by major powers (McManus and Nieman 2019), and include alternate measures of geography like distance (Weidmann, Kuse, and Gleditsch 2010). As the dependent variable is bounded between zero and one, a more appropriate model specification than OLS is a zero-inflated beta model, which is also included in the appendix and produces results that are substantively similar.

5 Conclusion

The primary purpose of a state's military is to improve their security. Despite a recognition that this is conditioned by considerations like economic and geographic constraints and differences in what security threats state face, military power is still treated as a fungible asset that varies in size, but not in composition. However, states differ in what military capabilities they choose for their security. When states with similar economic and geographic constraints choose different force structures it may be because the optimal force structure for is conditioned by

a state's cooperative security relationships. States do not just decide between internal and external balancing. External balancing influences how a state internally balances because what military capabilities a state needs is a function of the military capabilities their ally possesses.

These findings also point to a new mechanism by which states can prevent opportunism by alliance partners. Conventional wisdom holds that asymmetric alliances have trouble with reliability-enhancing features like precision, issue linkage, and institutionalization since the larger state does not need reliability enhancement and the smaller state cannot get it (Mattes 2012). Dominant states want to free ride on their smaller partners, but cannot because they have more at stake and thus end up over-providing (Olson and Zeckhauser 1966). Rather than coercing their allies into contributing, allies can engage in a strategic division of labor where each provides useful capabilities in a way that is incentive compatible for both partners. Specialization is thus a way of preventing opportunism by limiting adventurism by smaller states (resolving entrapment) and preventing abandonment by the larger state.

Convergence of foreign policy preferences and institutionalized hierarchy interact to shape the type of military capability portfolio a state maintains. Among other purposes, alliances help a state defend itself better than they could defend themselves alone. However, there are downsides to relying on other states for defense. Other states could behave opportunistically by defecting in a way that presents a risk to your national security and defense and second, coordinating that cooperation can be costly. As a result, alliances must contain ways to guard against the risk of opportunism and costs of coordination (Yarbrough and Yarbrough 2016). This insight can help inform current debates about changing NATO relations and identify the consequences of allies trusting each other less than they used to. These debates often turn to the question about whether allies are contributing enough to the alliance. But by looking at what states are contributing to the common defense, rather than how much they are spending,

new perspectives on burden-sharing and the value of the alliance may emerge. After all, the composition of military assets, not just the amount spent, is what is truly of tremendous consequence for how NATO deals with future threats.

By applying economic and business organization theories about patterns of production across actors in the same space, a theory of a shared production model of military capabilities identifies a way that states can get the benefits of specialized production – economic, political, and military – while minimizing the costs of omitting some assets while overproducing others. In this way, states strategically choose to functionally differentiate through interstate security cooperation when it is conducive to a division of labor across nations. This happens when intra-alliance bargaining can overcome the costs of opportunism and coordination that otherwise inhibit reliance on others in the high stakes realm of the security and survival of the state. These two problems can be overcome in alliances that have (1) high strategic compatibility and (2) are more hierarchical. When states are able to cooperate over security issues, that cooperation manifests itself as a division of labor with complementary military capabilities.

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