Overlapping Communities and the Coevolution of the Defense Cooperation-Conflict Networks

by

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Defense Date: March 25, 2024

Approved:

Kyle Beardsley, Supervisor

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Dissertation submitted in partial fulfillment of the requirements for the degree of
Master of Arts in the Department of Political Science
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ABSTRACT

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Abstract

Global networks are distinguished by the presence of communities varying in size, often overlapping to form "community brokers" states with memberships across multiple communities. Utilizing the Link Community Detection Algorithm (LCDA), this study posits two hierarchical influences of such overlapping communities on global security networks. Firstly, the cross-network effect argues that community brokers, through their involvement in various communities, attain an informational advantage, potentially mitigating inter-communal conflicts. Secondly, the network endogenous evolution effect suggests that diminishing reliance on a singular community may erode the credibility of community brokers in fostering communal security, diminishing their attractiveness as defence collaborators and intensifying rivalries among brokers. Using data on global defence cooperation and conflicts from 1990 to 2010, the study tests these hypotheses. While fixed-effect Logit models provide evidence for the cross-network effects, when incorporating the co-evolution of defense cooperation and conflict networks via Stochastic Actor-Oriented Models (SAOM), this effect has limited ability to explain interstate conflicts. However, SAOM elucidates a network hierarchy overlooked by dyadic models and supports the endogenous evolution effect: states with greater importance in multiple defence communities are less favoured as new defence partners, and community brokers show a reduced propensity to build direct defence cooperation links with each other. This research elucidates the complex dynamics and hierarchical structures shaped by overlapping communities within global networks, offering novel insights into the intricate web of interdependencies that underpin global security dynamics.

Dedication

Dedicated to my family for their unwavering support and love.

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Acknowledgements

I extend my deepest gratitude to my family for their unwavering support and assistance throughout my educational journey. Being away from home and navigating the challenges of pursuing higher education on my own could have been an overwhelmingly solitary experience. Yet, the constant encouragement, love, and faith you all have shown in me provided the strength and confidence needed to persevere. Your unconditional belief in my abilities has been the cornerstone of my success, and for that, I am eternally grateful. The sacrifices you have made and the unwavering support you have provided have been instrumental in my achievements. I cannot express enough how much your support has meant to me; without it, I doubt I would have reached this point.

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1. Introduction

This thesis project primarily investigates how overlapping communities and "community brokers", defined as states with multiple memberships across communities within the Defense Cooperation Agreement (DCA) network, affect the endogenous evolution of the DCA network, as well as the dynamics of conflicts between communities. The complex interdependence is a ubiquitous phenomenon in international relations (Keohane & Nye, 1973; Mansfield & Pollins, 2009), and the concept of social network is also not novel to the IR scholarship: interactions between countries, such as cooperation or conflict, are often influenced by "extra-dyadic factors"; more generally, a state's position within global economic, military, or diplomatic networks have profound effects on issues such as conflict, development, and global governance. On these issues, informal communities formed through bilateral or multilateral ties, that is, groups of nodes that are more closely connected internally than externally, may have far-reaching implications. However, current research on the role of communities within global networks and the advantageous positions states obtain through participation in different communities are still insufficient. Identifying the theoretical gap, this thesis project employs network data related to global defence cooperation, militarized interstate conflicts (MID), and advanced social network models, aiming to enhance and aid our understanding of the complex interdependencies within global networks and their impact on security situations.

1.1 Motivations

In international politics, states are linked to each other through ties of varying nature and strength. From a relational perspective, the study of international relations is essentially a study of the complex interdependence of states. Understanding state behaviour cannot be separated from the global network in which states are embedded, especially their position in this network and the ties they establish. In this process, the units of analysis (i.e., the "nodes" of the network) can be states, rebel movements, ethnic groups, international governmental organizations, or non-governmental organizations. The ties between nodes also vary widely, including trade or ethnic relations, military alliances and bilateral cooperation agreements. Drawing on these concepts, which are closely related to social networks, scholars of international politics can explain the outcomes associated with conflict and peace by examining the dynamics within networks of states, non-state actors, and transnational institutions.

Political science or international relations research based on social network theory or methodology has flourished(Beardsley, 2024; Beardsley et al., 2020; Kinne, 2012, 2014; Maoz et al., 2007). Nonetheless, the question of integrating broader social network theories, concepts, and methodologies with the concept of international politics remains open. In particular, the current exploration by international relations scholars of another key concept in social network theory - "community" - is still in its infancy.

Indeed, the notion of "community" is closely related to the study of international politics and, in particular, international security. In international politics, we can observe many communities, the most notable of which are formal communities defined through the formal organizational membership of transnational or inter-state organizations, such as the United Nations, the Group of 20, or NATO. In addition, there is an often-overlooked phenomenon known as informal communities. These communities are characterized by their formation and functioning relying on actual interaction and cooperation between individuals within a network rather than on formal, documented collective membership. From a network perspective, informal communities are essentially a set of states (nodes) that are more densely connected internally than externally(Fortunato, 2010; Fortunato & Hric, 2016). For example, while many economic and trade relationships are defined through formal multilateral free trade agreements or economic cooperation organizations, there are also naturally occurring economic communities based on long-term bilateral trade and investment relationships. Shared market interests, supply chain dependencies, or geo-economic strategies may reinforce these relationships. Most notable is China's Belt and Road Initiative. As of March 2022, 146 countries or regions have endorsed the Belt and Road Initiative, and 139 of these have signed Memoranda of Understanding (MOUs) with the People's Republic of China

(PRC), demonstrating the formation of communities through bilateral cooperation. In the field of international security, the U.S. alliance network is a typical example: In the Asia-Pacific region, although there is no formal regional security community between the U.S. and countries such as Japan and South Korea, a U.S.-centered community of defence cooperation has gradually formed through bilateral military alliances or military cooperation.

These phenomena imply that analyzing communities in international politics, especially informal ones, can reveal close cooperation or rival factions in international political networks, both explicit and implicit. For example, researchers can determine which international communities have formed by analyzing bilateral and multilateral economic partnerships or military alliances between states. These communities reflect integration or collective actions based on geopolitical interests, economic interests, or cultural identities. Community analysis also helps to reveal the informal structures and distribution of power in the international system, providing insights into classic issues in international politics by offering complementary perspectives to traditional theories of international relations such as realism and liberalism. Specifically, realism emphasizes power- and threat-based interactions between states, with theories involving military alliances and security communities, while liberalism focuses on the role of international cooperation and organizations; from a network perspective, the concept of community identifies communities formed based on common interests, cultural ties, or security threats. Internalizing concepts such as collective action and security dilemmas allows for a deeper understanding of the complexity of state behavior and the motivations behind it, thus transcending the limitations of a single theoretical framework.

Despite the increasing attention to the concept of community in political science and international relations research, most existing studies have employed traditional methods of community detection that presuppose the existence of "non-overlapping communities." This assumption dictates that each state (or node) is confined to a singular community, possessing a unique membership within that community. This dichotomic approach is deemed essential for accurately depicting formal community structures, which reflect the hierarchical relationships prevalent in the sphere of international politics. However, this perspective fails to acknowledge the complexity of informal communities, which emerge from bilateral or multilateral collaborations. By disregarding the presence of states that possess multiple communities memberships or the "overlap" between different communities, significant insights into the network's dynamics may be overlooked. This oversight is particularly problematic when considering the unique role of states with overlapping community affiliations—referred to here as "community brokers." These entities potentially wield considerable influence over international conflict and cooperation, underscoring the need for a more nuanced understanding of community structures in global politics.

In the intricate arena of international politics, the notion that countries strictly adhere to singular community affiliations within global networks falls short of capturing the dynamism inherent to international relations. A more accurate representation acknowledges the prevalence of overlapping communities. Take Germany as a case in point: its pivotal role within the European Union (EU) highlights its influence over economic integration, political unity, and crisis response within the region. Concurrently, Germany's membership in the North Atlantic Treaty Organization (NATO) underscores its commitment to transatlantic security and defense cooperation. This dual affiliations allows Germany to significantly contribute to European stability and foster stronger ties between Europe and the United States, showcasing its capacity to navigate multiple roles across different international platforms.

The United States exemplifies a similar versatility in its trade policies, engaging in various economic cooperation frameworks. Through its participation in the North American Free Trade Agreement (now known as the United States-Mexico-Canada Agreement, USMCA), it has bolstered economic relationships with neighboring countries. Furthermore, its initial involvement in the Trans-Pacific Partnership (TPP) — despite its eventual withdrawal — underscores its proactive stance in advocating for comprehensive regional economic cooperation. These instances reflect the United States' strategic approach to not only strengthen regional economic integration but also to extend its influence and set the agenda within the broader global economic network. This strategy of forming alliances and engaging with multiple groups simultaneously enhances the United States' ability to leverage bilateral interests within the larger fabric of global governance, thus facilitating international cooperation and exploiting strategic synergies within the complex global landscape.

1.2 Research Questions

Addressing the oversight of "overlapping communities" within the prevailing discourse on IR scholarship, this paper aims to illuminate the core attributes and interwoven nature of communities within the global network landscape, specifically assessing their influence on state conduct in the realm of international security. Central to this analysis are defense cooperation agreements (DCAs)networks, defined as "formal bilateral agreements that establish an institutional framework for daily defense cooperation"(Kinne, 2018). Unlike formal alliances, which generally remain inactive barring interstate conflict, the DCA network emerge from bilateral defense cooperation agreements, which provide a instituitionalized foundation for defense-related interactions among states, encompassing a broad spectrum of activities such as defense policy coordination, mutual consultation, military training and exercises, coordination in peacekeeping operations, defense research and development, industrial cooperation, weapons procurement, and the safeguarding of classified information(Kinne, 2020).

The significance of DCAs extends beyond their practical applications; they serve as a nuanced lens through which to examine the dynamics of interstate defense cooperation and the formation of informal security communities. Within the DCA network framework, the concept of "community brokers"—states that have multiple defense membership across various informal communities—emerges as a critical analytical tool. These community brokers act as vital conduits, facilitating communication, cooperation, and cohesion among disparate defense communities. By exploring the role and impact of these brokers within the defense cooperation networks, this paper aims to contribute a deeper understanding of the complex interplay between overlapping community structures and state behavior in international security sphere, thereby bridging a significant gap in the current scholarship on international network analysis.

Specifically, this paper asks two questions:

First, how does the presence and attributes of community brokers affect the propensity for conflict between different communities? More specifically, for a focal dyad belonging to different defense communities, how does the existence of "community brokers" between them affect the propensity of conflict and peace between them? The classic Structural Balance Theory suggests that common allies dampen the propensity for conflict between bilateral focal states because they possess the incentives, capabilities, and informational advantages to do so(Heider, 1946; B. K. Lee, 2023; Rawlings & Friedkin, 2017). I link this theory to the concept of community brokers to test the "extended common ally" effect. I employ a link-based community detection algorithm to identify overlaps in defense communities(Ahn et al., 2010). This approach identifies potential communities based on actual patterns of defense relationships and the likelihood of heterogeneous community membership, thus identifying what I define as "community brokers."

Second, I ask the following question in terms of network endogenous effects. Does the popularity of a country in multiple communities increase the likelihood that other countries will establish ties with it? A common phenomenon in social networks is 'preferential attachment', i.e. the tendency of new nodes to connect to nodes with more connections in real networks. This "preferential attachment" has been seen as a fundamental endogenous effect in networks.Kinne, 2018argues that preferential attachment in international relations is a direct reflection of an informational mechanism between states: states that sign a large number of DCAs signal and disclose valuable information about their trustworthiness and the types of agreements they are willing to sign, and therefore, when signing with these partners, the coordination and cooperation are less risky. When it comes to communities, however, the empirical exploration of their role in the endogenous evolution of networks and the specific mechanisms of their influence remains insufficient.

To address this gap, I focus on the concept of "community centrality" from overlapping community detection algorithms, a new variant of network centrality that measures the degree of popularity of community brokers across different communities. Based on the theoretical framework on bilateral and networked interests proposed by Kinne and Bunte, 2020a, I propose a framework to capture the trade-offs in states' decisions to establish ties in DCA networks: on the one hand, in terms of bilateral interests, establishing ties with brokers that span multiple communities allows countries to enjoy the benefits of valuable information about other communities, which predicts a greater willingness to establish ties with countries with a high degree of community centrality. On the other hand, however, in terms of the structural benefits of the network, states with higher community centrality are more likely to establish informal hierarchies within the DCA network by occupying a structural advantageous position of informational superiority, exerting disproportionate power over subordinate states in terms of their ability to control, influence, and coerce others. This network interest effect may discourage new states, especially subordinate states, from establishing ties with "popular" states in the DCA network with the aim of escaping structural influence. This bilateral-network interest dynamic trade-off complicates the decision-making process on linkages between states.

To empirically explore the above arguments, I employ novel community detection algorithms (CDA) and empirically test the research hypotheses using dyadic linear models and dynamic network models. I first used a linkage-based community detection approach to identify communities and states with multiple community memberships in the DCA network over the period 1990-2010. Descriptive analyses show that the DCA network consists of multiple overlapping and nested communities, rather than mutually exclusive and clearly-bounded groups. However, it prensents a hierarchical structure with only a few countries belonging to multiple communities. Notably, not all of these countries are traditional military or political powers, suggesting that the hierarchical structure in the DCA network with not depend entirely on economic or military power. I then briefly examine the determinants of community centrality, using community centrality as the dependent variable.

In the empirical analysis section, I first test the cross-network argument for "extended common ally" effect on conflict within a dyadic framework using a fixed-effect Logit model. To further address the issue of endogeneity between DCA and conflict networks, I built an stochastic actor-oriented model (SAOM) to simulate the co-evolution of DCA networks and conflict networks, further testing the cross-network argument and the network endogenous evolution argument. However, the findings are mixed: while the Logit model provides support for the common ally paciffying effect argument, this effect has a limited role in explaining interstate conflict when using the SAOM and considering the co-evolution of the two outcome networks. These results cast doubt on the expectation that expanding common allies would lead to paciffying effects. Instead, the study provides some evidence for the argument that states with higher community centrality are less likely to be the target of new defense partnerships. On the other hand, states with mutually higher community centrality were less likely to establish DCA ties with each other , suggesting the existence of implicit boundaries between a small number of community brokers, demonstrating a kind of competition within a hierarchical structure.

These mixed data findings further suggest that from an empirical perspective, the traditional dyadic framework fails to address endogeneity and may overestimate the role of common allies in explaining interstate conflict and cooperation. On the theoretical side, SAOM's results highlight competitive network hierarchies that are ignored by dyadic framework: community brokers gain structurally dominant positions by participating in different communities, and this competition leads to exclusion between states with similar hierarchical positions and may encourage other countries to refuse to connect with popular community brokers in order to avoid being coerced by network power.

1.3 Outline of the Thesis

The dissertation emphasizes the crucial interplay between theoretical frameworks and empirical data, highlighting the importance of merging research methodologies with theory to achieve a comprehensive understanding of international relations through a quantitative lens. This synthesis enables the transformation of theoretical concepts into measurable empirical quantities, paving the way for rigorous quantitative analysis and the enhancement of theory with empirical insights.

The remainder of the thesis is organized as follows: The second section begins with a thorough review of the literature on interdependence, network analysis, and community detection within the field of international relations. This section aims to map the current state of research, spotlighting significant advancements as well as areas where the concept of clustering has been overlooked. This foundational review sets the stage for the subsequent empirical and theoretical explorations.

The third section introduces a link-based community detection algorithm to extract communities within Defense Cooperation Agreement (DCA) networks. This approach not only identifies the communities themselves but also determine the community brokers within these networks. Additionally, this section delves into the determinants of community centrality among these brokers, providing insights into the underlying factors that influence their pivotal positions.

In the fourth section, the thesis elaborates on the theoretical underpinnings and formulates research hypotheses. It explicates two mechanisms through which community brokers exert endogenous and cross-network effects on the DCA network. These theoretical insights lead to the generation of specific, testable hypotheses that guide the empirical investigation.

The fifth section is dedicated to the empirical testing of the proposed hypotheses using logistic regression and Stochastic Actor-Oriented Models (SAOMs). This part offers a detailed explanation of the SAOM methodology and its application within the study. The section further discusses the nuanced, mixed findings from the empirical tests, providing a platform for a deeper exploration of the underlying mechanisms.

The thesis concludes by summarizing the main findings and theoretical contributions of the research. It underscores the integration of theory and empirical analysis as one of the key achievement of the study. Additionally, the conclusion acknowledges potential limitations of the current research and outlines avenues for future inquiry.

2. Related Literature: Social Network, Community and Internation Relations

Until recently, dyadic analysis stood as the foundational analytical approach in the quantitative exploration of international relations, particularly within the subfield of international security. Since at least the mid-1990s, dyadic data analysis has become increasingly common in large-N quantitative research(Oneal et al., 2003), which predominantly utilized "dyad-year" as the principal unit of analysis for conducting linear or non-linear regression models. These models aim to elucidate patterns of peace and conflict by examining dyadic or monadic attributes of the focal dyads to explain outcomes of peace and conflict. Within this traditional framework, the network aspect of international relations has been relegated to a mere backdrop or context, not actively engaged as an empirical variable with explanatory power.

Despite the achievements of dyadic studies in directing the quantitative analysis of international relations toward examining interactions among states over isolated state behaviours, this method harbours a significant conceptual limitation. Theoretically, the dyadic approach fails to encompass the broader notion of "interdependence" adequately. Contrary to this paradigm's assumptions, dyads do not exist in a vacuum; the dynamics within one dyad are often influenced by the activities of others, forming a complex web of interdependent relationships(Dorussen et al., 2016). This web extends beyond bilateral interactions, encompassing higher-order interdependencies within and across various networks. The phenomena of conflict initiation, escalation, and resolution, as well as the diffusion of cooperative behaviours, contribute to a sophisticated system of interdependencies that cannot be fully understood through dyadic lenses alone. The existence of intervening third parties, the influence of dominant states within the global network, and the interplay between different networks introduce complexities that transcend the focus of dyadic analysis. These considerations challenge the sufficiency of the dyadic paradigm and highlight the need for analytical frameworks that can capture the multifaceted nature of international interdependence, thereby advocating for an extended focus beyond isolated state dyads to include the intricate network of global interactions.

The critique of dyadic analysis, particularly with regard to methodology, becomes even more pronounced when considering the limitations associated with statistical inference. Cranmer et al. (2012) analyzes the significant methodological challenges inherent in applying dyadic classical regression techniques in international security studies through a study of alliance formation. Firstly, a fundamental assumption of regression analysis is that the independent and identically distributed (i.i.d.) nature of the data is conditional on the covariates. This presupposes that for any two dyads sharing similar covariates, their data-generating processes should be alike and mutually non-influencing. However, historical events, such as the intricate web of alliances prior to World War I, reveal that interdependence among states is a norm rather than an exception in international relations. This interdependence contradicts the exchangeability assumption, leading to biases analogous to those caused by omitted variables. Such biases can distort the analysis, erroneously attributing effects to dyadic or monadic factors that are, in fact, due to interdependent dynamics. Secondly, the issue of data "multiplication" arises when analyzing extensive panel datasets structured as "dyad-years." This methodological approach significantly inflates the number of observations relative to the actual number of actors (countries) generating the data. The inclusion of each additional country into the analysis exponentially increases the total number of dyadic observations, leading to what can be termed a "large sample curse." This phenomenon results in artificially minor standard errors as the dataset expands non-linearly, making it more difficult to conclude that the effect of a covariate is statistically insignificant.

Acknowledging the limitations of dyadic analysis, alongside a deepening understanding of the role of interdependence within the realm of international relations, there has been a marked shift towards incorporating extra-dyadic or network factors into empirical analysis. This evolving perspective acknowledges that the behavior of an individual actor or a dyad may be influenced by a broader array of actors/dyads or by the overarching network structure itself. Initially, this line of inquiry primarily aimed at descriptively mapping the web of interstate connections and pinpointing clusters of states that demonstrate dense network ties within the international system, as highlighted in early works by scholars like Gleditsch (1967) and Skjelsbæk (1972).

As social network methodologies, particularly those enabling statistical inference analyses, have advanced, network analysis has emerged as a potent tool for exploration into the forces driving interstate conflicts and peace, as well as the broader dynamics of international cooperation. Notable applications of network methods have spanned a variety of contexts, including but not limited to, the investigation of interstate disputes and wars(Beardsley et al., 2020; Galambos, 2024; Gartzke & Westerwinter, 2016; Li & Reuveny, 2011; Lupu & Traag, 2013; Maoz, 2009; Maoz et al., 2007), international cooperation(Haim, 2016; Kinne, 2012; Zille, 2023) , and the alliance formations and dynamics(Cranmer et al., 2012; Kinne, 2018) .Beyond the inter-state level, network analysis has also ventured into the domain of subnational conflict studies, shedding light on more phenomena such as the interplay among rebel groups and the processes of war mobilization(Dorff et al., 2020; Larson & Lewis, 2018; Larson et al., 2019). This broadening of focus reflects an increasing recognition of the complex, interconnected nature of international and subnational conflicts and cooperation. By leveraging network analysis, researchers are able to uncover the multi-layered relationships and structural dependencies that shape global political interactions, offering richer, more nuanced insights into the patterns of conflict and collaboration that define the international system.

Despite significant progress, a persisting challenge remains in more effectively integrating network factors with the foundational concepts and theories of IR. Specifically, this challenge revolves around how network factors can be comprehensively incorprerated in model specification of empirical analysis. Presently, the literature on international relations delineates two primary approaches to addressing this challenge: firstly, by incorporating network endogenous factors—such as centrality, triadic closure, and Homophily—which resonate with the classical theories of social network analysis, including Structural Equilibrium Theory, Preferential Attachment, and Reciprocity Mechanisms, into the statistical models underpinning the research(Haim, 2016; Kinne, 2018; Maoz, 2009).

Another approach is to use network inference models such as the Exponential Random Graph Model (ERGM) or the Stochastic Actor Oriented Model (SAOM). These innovative models conceptualize the network itself as the dependent variable, adeptly integrating a wide spectrum of network endogenous effects, including but not limited to reciprocity, transitivity, and star structures. This integration is achieved through a flexible setup of the estimation proces and model specification, affording researchers adaptability in their analysis. Moreover, these models inherently account for temporal dynamics, rendering them exceptionally suited for the examination of dynamic network data.

Notably, SAOM stands out for its capability to address the co-evolution of networks and node behaviors or attributes. This feature enables an in-depth exploration of the intricate interplay between networks and the behaviors of their constituents. An example of this application is Kinne (2016) research, which leverages SAOMs to investigate the effects of Weapons Cooperation Agreements (WCAs) on global arms trade dynamics. Kinne (2016) posits that WCAs form an interdependent network that evolves concurrently with arms trading activities at the state level. Utilizing SAOMs, he demonstrates the bi-directionally endogenous relationship between WCAs and arms flows, revealing that WCAs significantly bolster arms trade volumes.

In this study, I endeavor to meld the aforementioned approaches to both enrich theoretical development and facilitate empirical analysis. My focal point is a concept of social network theory: community. The term "community" lacks a universal definition; generally, it implies a grouping of nodes characterized by a greater number of connections within the group than those linking the group's nodes to the remainder of the network. Adopting a more formal graph-theoretic lens, a social network can be envisaged as a graph composed of nodes (representing individuals or entities) and edges (denoting the relationships among nodes). Within this framework, a community is identified as a subgraph distinguished by a notably higher density of internal connections relative to those extending beyond its boundaries. It is important to note that community definitions are predominantly algorithmic in nature; that is, communities are typically the output of a specific algorithm without a precise predefined conceptualization(Fortunato, 2010; Fortunato & Hric, 2016).

The exploration of community within the domain of IR extends a rich tradition of scholarly efforts aimed at uncovering and defining subsystems, communities, and blocs that characterize the international system. B. K. Lee (2023) posits that the methodology for identifying communities within IR scholarship has undergone a significant evolution, transitioning from reliance on a prior knowledge to adopting inductive methodologies for community detection. Historically, researchers in the field of international relations defined communities as groups of states that exhibited higher levels of interaction with one another "ex post" compared to others. This traditional approach involved identifying community based on state interactions or geographical proximity, subsequently positing that a state's membership within a given community could predict its likelihood of engaging in specific behaviors. However, this method often resulted in tautology and failed to yield consistent and reliable outcomes in community detection.In contrast, the more recent, inductive path embraces the use of community detection algorithms to "partition" networks into communities. This approach is grounded in the actual patterns of connectedness, focusing on identifying groups of states that demonstrate either similar behaviors or a high degree of interaction intensity. By leveraging empirical network data, this inductive strategy facilitates a more objective and replicable identification of community within the international system.

The concept of community has a wide range of applications in IR research. For example, community analysis can capture the hierarchies and structures that communities have since global governance involves the intersection of multiple levels and domains, including economy, security, environment, etc. The concept of communities can help to understand the structure and dynamics in global governance networks, revealing which countries or international organizations play a central role in particular areas and how they influence global policy and norm-setting through collaborative networks. In addition, interactions between communities can help predict trends in the evolution of international relations. For example, by monitoring changes in the structure of communities between countries, it is possible to detect emerging trends in international cooperation or signs of tensions between certain states in advance.

Recent scholarship on international relations has used community detection methods to identify potential communities in a number of international networks. For example, Lupu and Traag (2013) used a modularity maximization approach to reveal communities in global trade networks. They found that trade flows form trade communities with relatively dense trade ties, and intra-community conflicts may lead to trade disruptions. Internal conflicts occurring in trade communities formed by indirect trade links generate higher negative externalities compared to direct trade links, leading to higher opportunity costs associated with trade disruptions and thus incentivizing group members to suppress their own conflict tendencies and prevent conflicts from occurring. Greenhill and Lupu (2017) similarly utilize modularity maximization to reveal communities in networks of intergovernmental organizations (IGOs). Their study shows that the IGO network consists of three core communities: the African community, the European/Northern community, and the Latin American community.Beardsley et al. (2020), on the other hand, found that in communities comprised of heavier weapons trade with higher irreplaceability, common membership can impose high switching costs for breaking trade ties. The result is that heavy arms trade reduces intra-community conflict, and powerful states can use the advantages of hierarchical status within the community to constrain the conflict tendencies of subordinate states.

While recent empirical studies utilizing community detection algorithms have yielded robust empirical insights into the dynamics of international networks, they are not without their methodological limitations. A significant limitation inherent to these studies stems from the foundational premise of the community detection algorithms employed: the assumption that each node within the network is affiliated with a singular community, excluding the possibility of multiple community memberships. This limitation originates from the initial stages of community detection algorithm development, which primarily focused on identifying distinctly separate communities within networks. As the field of social network analysis evolved, researchers began to acknowledge the nuanced reality of real-world networks, where communities often exhibit significant overlap rather than clear demarcation. This recognition has spurred a shift towards the development and application of algorithms capable of identifying overlapping communities(Fortunato, 2010; Fortunato & Hric, 2016).

The concept of overlapping community is not uncommon in international politics. For example, states often form alliances with different states based on a variety of factors, such as security, economic or cultural, creating complex networks of friendship and confrontation. A state may be a member of multiple security alliances at the same time, or it may maintain cooperative relationships with certain security adversaries in the economic sphere. The community overlapping perspective can help scholars make sense of these seemingly contradictory international relationships and reveal underlying structural tensions and opportunities for cooperation in the international system. In addition, international organizations and multilateral institutions are important players in international politics, and they often serve as platforms for cooperation among multiple states. Many countries will participate in multiple international organizations at the same time, such as the United Nations (UN), NATO, the World Trade Organization (WTO), and the World Health Organization (WHO), etc., and this pattern of participation can also be viewed as overlapping communities in network analysis. By analyzing the structure of these overlapping communities, researchers can identify which countries play a central role in global politics and how different international organizations are interconnected and influence each other.

In the next section, I will present the link-based community detection algorithm developed by Ahn et al. (2010). I will use this algorithm to identify communities in global defense cooperation networks and states with multiple community identities, and briefly analyze the patterns of data presented by the degree of community centrality of these " community brokers".

3. Link Community Algorithm and Global DCA Network: A Descriptive Analysis

3.1 Introducing Community Overlap: the Link Community Algorithm

The development of algorithms for detecting overlapping communities aims to address the constraints inherent in conventional community detection algorithms. Within real-world social networks, nodes—such as individuals or states— generally possess inherent affiliations to multiple communities, rendering the phenomenon of overlap(Xie et al., 2013). This progression underscores a pivotal shift towards accommodating the complex, multi-faceted identities that define entities within these networks, thereby offering a more nuanced understanding of their structural dynamics and interconnections.

A plethora of algorithms have been developed to achieve the objective of identifying overlapping communities, including but not limited to the Clique Percolation Method (CPM) (Palla et al., 2005), Local Expansion and Optimization techniques(Lancichinetti et al., 2009), and Fuzzy community detection algorithms(Gregory, 2010). The algorithm selected for application in this thesis is the Link Community Algorithm, innovatively developed by Ahn et al. (2010). This algorithm's foundational principle builds on elucidating the community structure through the partitioning of links rather than nodes. Consequently, a node qualifies as an overlapping node if the links that connect it within the original graph are allocated to more than one cluster. Empirical evaluations have demonstrated that the Link Partitioning algorithm exhibits a more comprehensive performance relative to conventional methods, notably surpassing clique percolation, greedy modularity optimization, and Infomap in efficacy. It is imperative to note, however, that a comparative analysis of the performance of various algorithms extends well beyond the scope of this thesis. For an extensive review of algorithms dedicated to overlapping clustering, see work by Xie et al. (2013).

Formally, the Link Partitioning algorithm uses Jaccard coefficients to measure the similarities between links that share one node and uses these similarities to perform hierarchical clustering of links. For example, for two links e_{ik} and e_{jk}, which share a node k, the link similarity is calculated as:

$$S\left(e_{ik}, e_{jk}\right) = \frac{|n_{+}(i) \cap n_{+}(j)|}{|n_{+}(i) \cup n_{+}(j)|} \tag{3.1}$$

where $n_{+}(i)$ refers to the first-order node neighborhood of node i, which includes node i itself (inclusive neighborhood set). After the link similarity is calculated and assigned to all link pairs in the network, the links are hierarchically clustered using the single-linkage clustering method. Cutting this dendrogram at some threshold yields link communities. The decision of the threshold can be set by the analyzer or based on the calculation of partition density. Specifically, the optimal threshold is set at a point such that, after normalizing against the maximum and minimum numbers of links possible in each cluster, the point maximizes the link density within clusters, i.e., maximizes the partition density and minimizes the link density between clusters(Ahn et al., 2010; Kalinka, n.d.).

3.2 The Defense Cooperation Agreement Dataset (1990-2010)

cIn this section, I introduce The Defense Cooperation Agreement Dataset, developed by Kinne and Bunte (2020b), to construct the Global Defense Cooperation Network. DCAs, rather than formal military alliances, are chosen to define the defense community because governments have signed few new alliances in recent years, and the global alliance structure has remained relatively static for an extended period compared to the more active DCAs(Kinne & Bunte, 2020b). The relative stability of formal military alliances in international relations is attributable in part to the nature of alliance politics and the security dilemma. Arguments in favor of the effectiveness of military alliances suggest that they enhance a country's security by deterring potential aggressors and providing an external counterbalance to new members. However, empirical findings on the effectiveness of alliance deterrence are mixed at best. Indeed, the logic of the security dilemma suggests that conflict behavior and alliance networks are best understood in terms of co-evolution.

Beardsley (2024) employs the Stochastic Actor-Oriented Model (SAOM) to delve into this interplay, revealing that security support networks transform interstate security dilemmas into intergroup challenges. A state is aligning with a militarily potent yet ideologically divergent ally risks being perceived as a vulnerability within its alliance, attracting external or internal threats.

Moreover, the obligatory nature of military alliances, entailing significant commitments, renders the formation of new alliances a daunting and often prohibitive endeavor. The recent Russian incursion into Ukraine underscores this co-evolutionary perspective. Ukraine's strategic tensions with Russia and its consequent efforts to secure checks and balances through NATO membership triggered a preemptive conflict response from Russia. Furthermore, NATO's concerns about entrapment precluded a firm defense commitment to Ukraine, effectively stalling the formalization of an alliance despite substantive military cooperation.

While the formation dynamics of alliances are beyond this paper's scope, the discussion underscores that formal military alliances might not comprehensively reflect governments' security and defense strategies, thus proving to be an inadequate basis for constructing a defense cooperation network. Consequently, this study utilizes Kinne and Bunte (2020b) database of defense cooperation agreements as a more representative dataset for crafting a global defense cooperation network. Post-Cold War, over 1,000 bilateral defense cooperation agreements have been ratified, encapsulating routine military interactions and offering a broader spectrum of defense cooperation policy. Unlike traditional military alliances, these agreements often encompass non-traditional security issues, aligning more closely with the defense cooperation community concept this paper explores. The forthcoming section will employ the Link Community Algorithm to dissect global defense cooperation networks from 1980 to 2010, presenting visual analyses for select years.

3.3 The Defense Cooperation Network and Community

Utilizing the Defense Cooperation Agreement Dataset (DCAD) spanning 1980 to 2010, this analysis operationalizes countries as nodes within a given year t, and the ties between them as the existence of any form of DCA in that given year. Despite Kinne and Bunte (2020b)'s categorization of DCAs into various types and levels, this study includes all DCA types to fully capture the dynamics of the global defense cooperation network (GDCN).

A challenge arises from the fact that prevalent community detection algorithms are predominantly designed for static networks, lacking mechanisms to directly accommodate the temporal dependencies inherent in dynamic networks. Nevertheless, the Link Community algorithm is employed for its compatibility with our objectives; it discerns communities based on the actual patterns of connectedness of existing states, thus mitigating concerns related to temporal dynamics. Accordingly, the DCA dataset, initially structured as "dyad-years," is segmented by years for the purpose of community detection. The Link Community algorithm then constructs a dendrogram for each year, delineating the structure of link communities within the GDCN. For illustration, Figure 3.1 depicts the Link Community Dendrogram for 2010, where each leaf signifies a DCA linkage, and branches represent each defense cooperation communities.In the graphic's far right, the "Partition Density" metric of the Global Defense Cooperation Network (GDCN) for the specified year is displayed. As previously discussed, "Partition Density" reflects the density of links within clusters. Unless the height of the cut is set artificially, LCA cuts the dendrogram by default at the height at which "Partition Density" is maximized, resulting in 43 potential clusters, including 153 countries and 889 DCA ties.

In order to more clearly visualize the distribution of the GDC network in 2010, I used linkcomm's built-in plotting functions to draw a graph layout of the network with coloured link communities (Figure 3.2) and community membership matrix (Figure 3.3) .

Figure 3.2 employs the Spencer circle for its foundational visualization framework, systematically positioning communities around the circle's perimeter in accordance with the

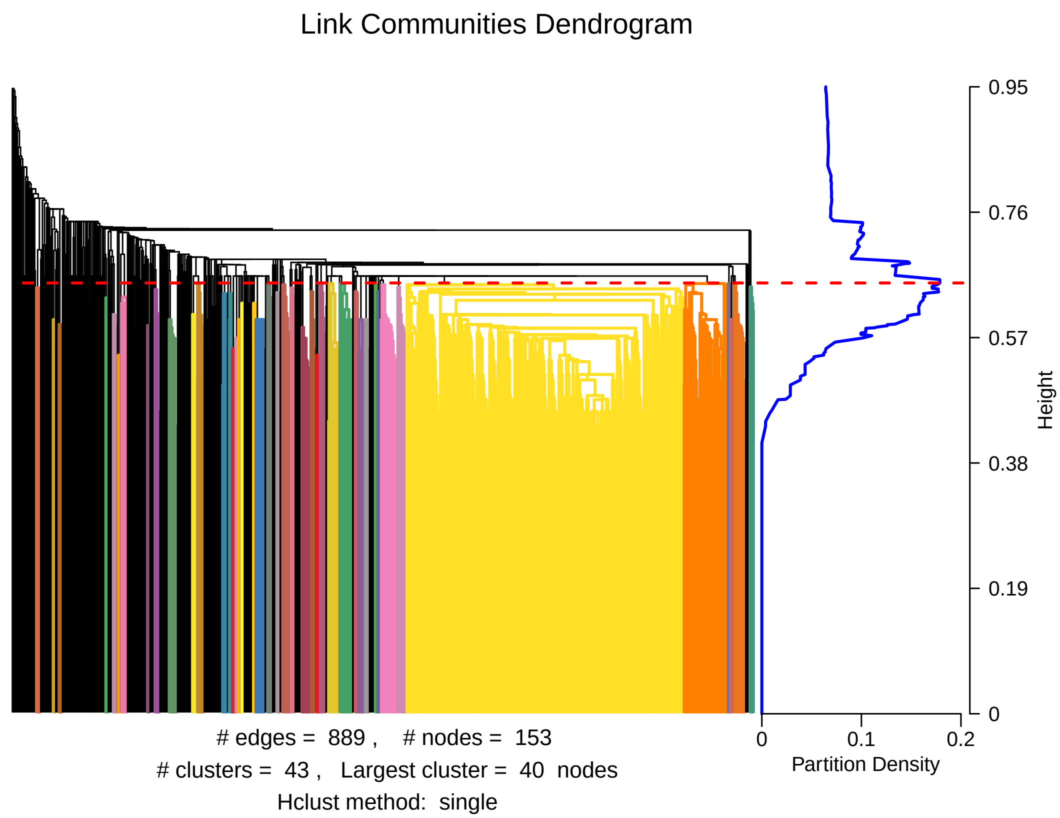

FIGURE 3.1: Link Community Dendrogram for 2010

dendrogram sequence to reduce link crossover. Nodes are placed within the circle relative to their link count across different communities, naturally driving those with connections to numerous communities toward the circle's center. Furthermore, nodes situated in the central area of the graph, which are associated with multiple communities, are depicted using pie charts. These charts illustrate the distribution of all the node's connections among the respective communities, providing a clear visual representation of the node's diverse community affiliations.

Figure 3.3 presents a matrix of community memberships, offering a detailed overview of the community distribution patterns depicted in Figure 3.2. This matrix highlights the fifteen countries with the most extensive involvement in community within the GDCN in 2010, along with their specific communitiy affiliations. The figure reveals notable trends

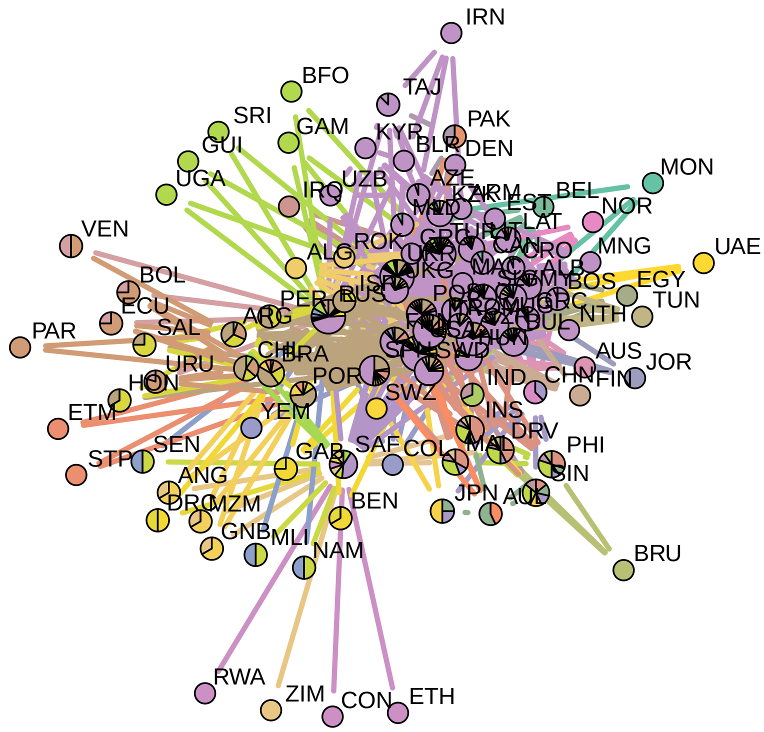

FIGURE 3.2: Layout of the (GDCN) with Coloured Link Communities for 2010

in global defense cooperation for that year. Firstly, the United States, Russia, Ukraine, the Czech Republic, Turkey, and Italy are distinguished by their membership in over ten communities, reflecting the United States and Russia's significant military capabilities and their proactive engagement in global security dynamics. Secondly, the majority of the highlighted countries, including the U.S., Turkey, Italy, Czech Republic, Poland, France, Spain, and Bulgaria, are NATO members, while others like South Africa, Indonesia, and Vietnam are recognized as regional powers. Ukraine's prominent position in the matrix can be attributed to its significant role in the global arms trade during the 2000s.

To delve deeper into the formation patterns of "community intermediaries"—namely,

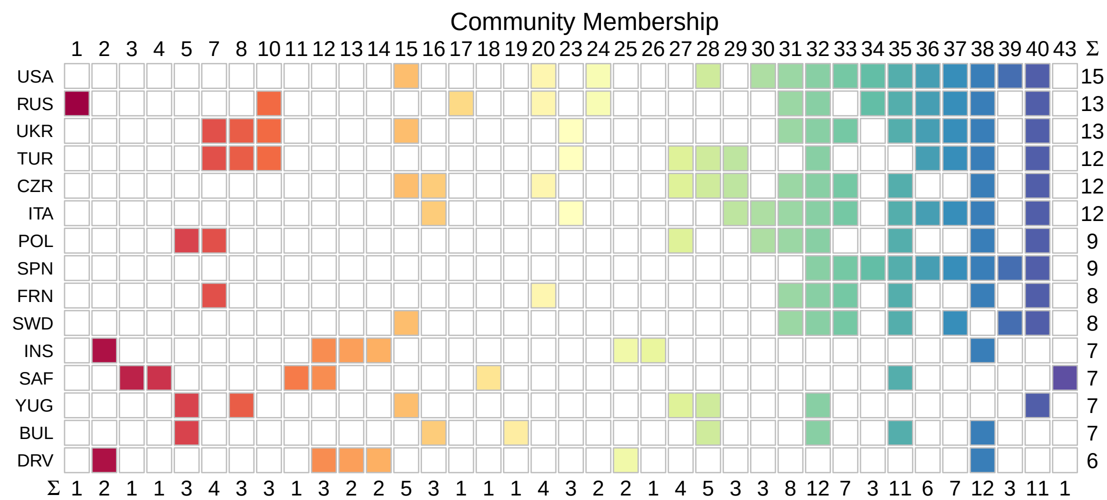

FIGURE 3.3: Community Membership Matrix for 2010

countries that hold memberships in multiple communities within the Global Defense Cooperation Network (GDCN)—I propose the use of an indicator termed "community centrality." This indicator is aimed at quantifying a country's significance across various communities within the GDCN. The concept of community centrality, introduced by Kalinka and Tomancak (2011) offers a community-entric approach to determining node centrality, standing as an innovative alternative to the conventional centrality metrics.Formally, the metric uses an algorithm based on "community weights" that weight each community to which a node belongs according to how similar it is to the other communities to which the node belongs. The community centrality of node i is calculated as:

$$C_C(i) = \sum_{i \in j}^{N} \left(1 - \frac{1}{m} \sum_{i \in j \cap k}^{m} S(j,k) \right) \tag{3.2}$$

where $S(j,k)$ is the similarity between communities j and k, computed by the Jaccard coefficient of the number of shared nodes between each pair of communities. Subsequently, the average of the m communities paired with community j and to which node i jointly belongs is computed. Finally, the N communities to which node i belongs are summed. Community centrality intuitively operates as a weighted measure of community membership, accounting for the distinctiveness of each community a node is part of relative to other communities the same node belongs to. A higher community centrality score for a country indicates its affiliation with a diverse array of distinct GDCN communities, signifying a broad and varied defense engagement. Conversely, a lower community centrality score suggests that the country's defense cooperation involvements are concentrated within overlapping and nested communities, pointing to a more focused or regionalized set of defense cooperation relationships. This metric thus offers insightful perspectives into the nuanced positions countries occupy within the global diplomatic landscape, highlighting the breadth or concentration of their international cooperative endeavors. Figure 3.4 illustrates the relationship between community centrality and traditional centrality metrics across various countries within GDCN. Regarding degree centrality, the observed correlation coefficient of 0.831 indicates a strong association between these measures. This substantial correlation not only underscores their interconnectedness but also highlights distinctions, shedding light on novel insights.

In GDCN, does a country's degree of cluster centrality depend on its own structural factors, such as polity, comprehensive national power, economic strength, or military inputs? While community centrality is generally treated as an endogenous variable within network models, I construct a panel regression model to examine community centrality as the outcome variable, integrating key structural variables such as democracy, military expenditure per capita, the Composite Index of National Capability (CINC), and the values of total arms trade, arms imports, and arms exports. To account for all time-invariant individual characteristics, as well as time trends or shocks common across entities, the model incorporates both country-specific and year-specific fixed effects. As depicted in Figure 3.5 through a forest plot, the findings reveal a significant and positive association between total arms

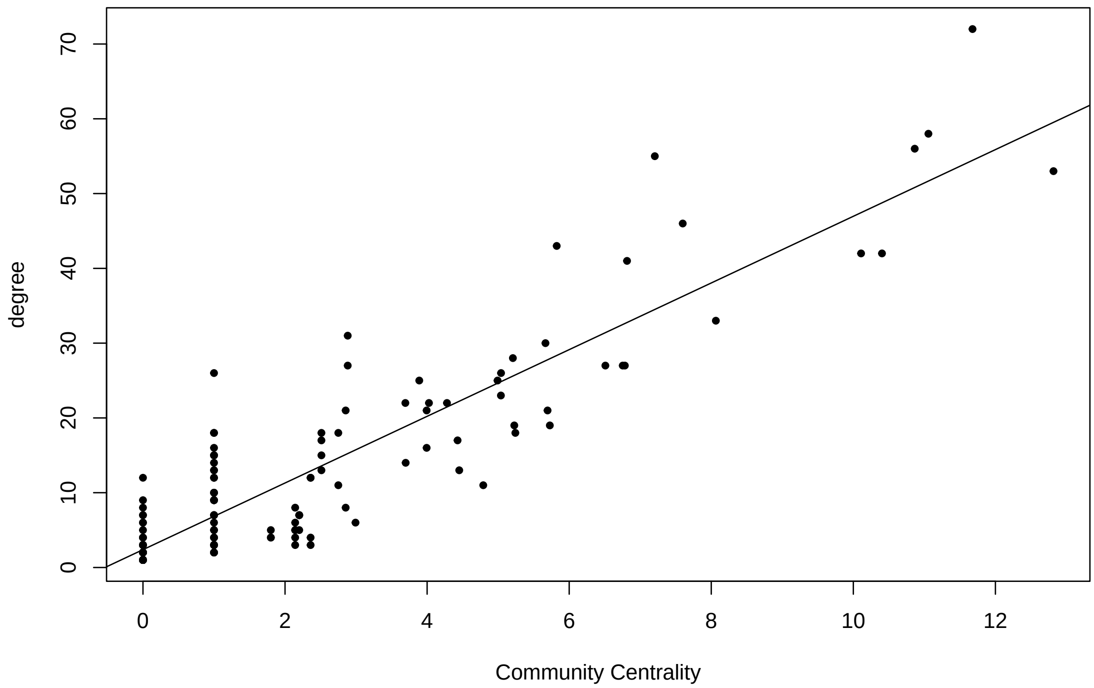

FIGURE 3.4: Correlation of Community Centrality and Degree Centrality

trade and a country's community centrality; specifically, a 1% increase in total arms trade corresponds to a 0.11 increase in community centrality. Contrary to expectations, both per capita military expenditure and the CINC index are significantly negatively correlated with community centrality. A 1% rise in per capita military expenditure results in a 0.31 decrease in community centrality, whereas a similar increase in the CINC index leads to a substantial 0.81 reduction in community centrality.

Integrating both visual descriptive analysis and regression analysis yields insightful conclusions regarding the GDCN. Firstly, the network's structure is characterized by multiple overlapping communities, eschewing the notion of mutually exclusive, clearly delineated groups. Concurrently, the network exhibits a hierarchical architecture, where a limited number of countries can simultaneously belong to various communities. Nevertheless, the prominence of a country within the community network is not solely determined by the

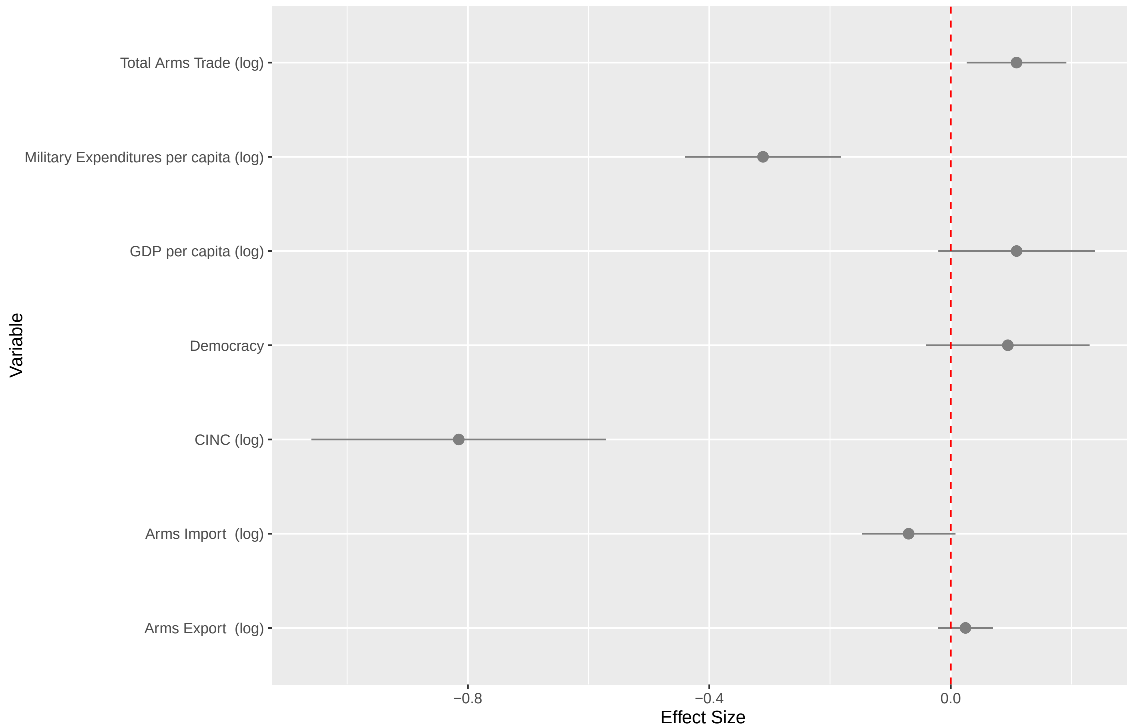

FIGURE 3.5: Fixed-Effect Model for Community Centrality (1980-2010)

material prowess of the leading powers. The regression analysis indicates that variables reflecting network interaction (e.g., total arms trade volume) positively influence community centrality. In contrast, nations heavily invested in military endeavors and possessing substantial national power might find their significance in the community diminished. This phenomenon could shed light on the observed network dynamics within the GDCN: notably, the United States and Russia, as global political superpowers, command the highest levels of community centrality.

Meanwhile, countries such as Ukraine, Spain, and Italy elevate their standings through active participation in the global arms trade. On the flip side, despite their burgeoning comprehensive national power, countries like China and India have seen their influence confined to regional defense communities, as illustrated in Figure 3.6. In 2010, China was associated with merely two defense communities, with one marked in green, comprising exclusively East or Southeast Asian states.

(a) China

(b) USA

FIGURE 3.6: Layout of Community Membership of China and USA (2010)

Overall, the analysis of the GDCN following the introduction of the overlapping communities conceptj reveals complex patterns of interaction and hierarchical structures in global defense cooperation. In the next section, I will continue this conceptualization by suggesting the influence of "community brokers" in explaining interstate conflict, as well as the endogenous evolution of the GDCN.

4. Theory

The analysis delineated in the preceding section reveals a complex tapestry of overlapping defense cooperation communities within the Global Defense Cooperation Network. This network, characterized by members' affiliations to multiple communities, has evolved into a more stratified structure, where a limited group of states achieves distinguished hierarchical positions through their active engagement across various community interactions. Interestingly, the regression analysis unfolds that these pivotal "community brokers" are not necessarily the most materially powerful states. Instead, their emergence is a product of the intricate network architecture, suggesting that their strategic positioning may significantly influence global security dynamics. The role of these "community brokers" in the network's structural hierarchy could thus have far-reaching implications for the patterns of global security. Such impacts might manifest in a trans-network manner—where a state's status as a "community broker" within the GDCN affects its influence on conflict and cooperation dynamics across the network—or be network-endogenous, contributing to the evolution of global defense cooperation network itself.

This section asks two targeted inquiries: Firstly, from a cross-network perspective, how does the function of a 'community broker' alter the likelihood of conflict among the communities to which they belong? Secondly, within the network, how do "community brokers" drive the endogenous development of the global defense cooperation networks? This analysis draws upon foundational social network theories, notably structural balance theory to underpin these discussions.

4.1 How Community Brokers Influence Interstate Conflict Tendencies

The marriage of social network analysis and international relations brings a nuanced understanding of how state interactions are influenced not just by bilateral ties but also by the broader network of relationships in which these ties exist. This perspective is particularly illuminated through the concept of the "triad," a framework borrowed from social network analysis that allows scholars to examine the dynamics between three entities—be it countries, groups, or individuals—and their implications for international relations.

Triads in international relations often manifest in scenarios like third-party interventions in interstate wars, where the initial conflict between two states (the dyad) is influenced by the actions and relationships with third states. These triangular relationships are crucial for understanding not only the immediate conflict dynamics but also broader strategic and diplomatic relations. The structure of a triad, which includes aspects like the strength, direction, and nature of relationships among the three nodes, is vital in deciphering the potential outcomes and behaviors of the involved states.

The theoretical underpinning of this approach is deeply rooted in the structural balance theory introduced by Heider (1946). This theory, emanating from the realm of psychology and social network research, provides a powerful lens for analyzing the stability and changes in social group structures through the dynamics of triadic relationships. It posits that triads can be either balanced or unbalanced based on the nature of the relationships (positive or negative) among the three entities. Balanced triads, where relationships are mutually positive or where two negative relationships are counterbalanced by one positive relationship, are seen as stable and harmonious. Conversely, unbalanced triads, characterized by a mix of positive and negative relationships not conducive to stability, are seen as sources of social tension and conflict.

The implications of structural balance theory for international relations are profound. It suggests that states, much like individuals in a social network, seek balance in their relationships. This drive toward equilibrium can explain shifts in alliances, the emergence of new partnerships, or the escalation and de-escalation of conflicts. The theory underscores the importance of examining not just direct interactions between states but also the broader network of relationships that might influence these interactions. The formal application of social balance theory to international relations posits that states, as nodes within a global network, engage in relationships—represented as edges—that are either friendly or hostile. These relationships are not random but rather reflect a discernible pattern aimed at achieving a state of equilibrium within the international system. The principle of seeking balance explains why states tend to align with others who share similar interests, values, or adversaries. This alignment is often driven by strategic considerations, where the familiar adage "the enemy of my enemy is my friend" comes into play. Such alliances are not merely opportunistic but are structured around the goal of establishing a balanced state within the international network that maximizes security and minimizes conflict for the involved parties. This reflects a systematic approach to understanding international relations, where states are motivated by the desire to maintain or achieve a harmonious balance in their external relationships(B. K. Lee, 2023; Maoz et al., 2007).

Moreover, the social balance theory sheds light on the durability of hostile relationships between states. In an equilibrium-focused international system, hostilities may persist not out of sheer animosity but because their continuation serves to maintain a certain balance among states. Altering these hostile relationships could potentially destabilize the existing balance, leading to uncertainty and possibly more detrimental outcomes for the involved states. Therefore, some conflicts endure over extended periods as they contribute to a form of stability within the regional or global context by maintaining the status quo or by preventing the emergence of a more chaotic or unbalanced international environment.

This perspective on international relations highlights the complexity of state interactions, where decisions to form or maintain alliances, as well as to sustain hostilities, are deeply influenced by the broader network of state relationships. States are thus seen as rational actors within a global system, where their actions are not isolated but are part of a larger pattern of behavior aimed at achieving a desirable state of balance. The implications of this theory are vast, offering insights into the strategic calculations behind foreign policy decisions, the formation of international coalitions, and the persistence of global conflicts. It underscores the importance of considering the international system as an interconnected web of relationships where the dynamics of balance play a crucial role in shaping the behavior of states.

Established international relations research on triad has emphasized the concept's role in explaining the relationship between cooperation and conflict between states. For example, S. C. Lee et al. (1994)'s pioneering work in developing formal models using the triad concept marks a significant advancement. By applying the concept to study the evolution of the international system, S. C. Lee et al. (1994)'s models suggest that unipolar and bipolar systems exhibit tendencies toward persistence and self-reinforcement. This is evident in the observation that both positive and negative ties tend to increase over time within these systems. Specifically, in a unipolar system, an increase in positive ties is associated with greater international integration, indicating a movement towards cooperation and unity among states. Conversely, in a bipolar system, an increase in negative ties correlates with a higher likelihood of conflict, pointing to the inherent tensions and competitive dynamics that characterize such a system. Maoz et al. (2007) further expand on this foundational work through their empirical investigation into the effects of triangular ties on state behavior. Their findings elucidate the mechanisms through which equilibrium and unbalanced relationships shape patterns of alliance formation and conflict engagement. In balance situations, states demonstrate a propensity to align with "friends of friends," fostering networks of cooperation and mutual support. This pattern aligns with the principles of social equilibrium theory, where balanced relationships contribute to stability and harmony. On the other hand, in unbalanced relationships, states are more inclined to form alliances with "friends of enemies" and to engage in militarized conflicts or wars with "enemies of enemies." Such dynamics reveal the complex interplay between relationship balance and state behavior, highlighting how states navigate their external relations in pursuit of security and strategic advantage.

B. K. Lee (2023), on the other hand, explores the effect of differences in the attributes of nodes in triangular relationships on the duration of rivalry. Overall, a rivalry is more likely to end when it has a common ally (information flow) or common enemy (prioritization). In particular, minor-minor rivalry, compared to major-minor, is more likely to be affected by third parties in the triad relationship, as the former is more likely to enhance the probability of competition termination due to the intervention of a common ally of a major power, while the latter is more likely to terminate the rivalry due to the presence of a common enemy.

Recent studies have extended the triad concept to explore the nexus between international and domestic politics. Notably, Kinne and Kang (2023)'s investigation posits that the survival of political leaders is intricately tied to their strategic triad with subnational actors, such as civilians, the military, and political entities. Their study highlights how a structural imbalance within domestic political triangles—manifested through subnational actors engaging with the enemies of allies or conflicting with the allies of friends—amplifies the propensity for leaders to exploit foreign relations for personal gain, thus securing their position of power. In addition, in some studies that use network evolution itself as the dependent variable, researchers often include transitivity to measure the tendency of triadic closure, i.e., the tendency of three nodes to form a closed triangle in a network(Kinne, 2018). Specifically, transitivity refers to the tendency that if, in a social network, Individual A is related to Individual B, and Individual B is related to Individual C, then Individual A and Individual C are also likely to have a relationship. Transitivity can be used to explain the endogenous evolutionary mechanisms of networks and is also essential for understanding information flow, trust construction, and the formation of social capital in social networks.

At the heart of triadic relationships in international relations is the "common ally" effect. When the focal dyad is engaged in conflict and shares a common ally, this creates a state of unbalance within the triad. Achieving balance in such scenarios involves the common ally acting in ways that can significantly mitigate the conflict tendencies between the two opposing states.Kinne and Kang (2023) and B. K. Lee (2023) highlight several mechanisms through which a common ally can exert influence to de-escalate tensions. Firstly, the common ally may serve as an effective mediator between the conflicting states, acting as a conduit for essential information. This role involves facilitating communication between the parties in tension, thereby reducing issues related to asymmetric information such as doubts about trustworthiness and understanding of preferences. By bridging the information gap, the common ally can help clarify intentions and foster a more conducive environment for conflict resolution. Secondly, while common allies can act as potential mediators, they also face their own challenges, particularly the risk of being entrapped into the conflict themselves. This predicament, however, generates a unique form of deterrence. Both states in the focal dyad may hesitate to intensify hostilities due to the unpredictability of the common ally's stance and the potential consequences of their involvement.

In summary, the common ally within a triad possesses the motivation, information, and capability to significantly lower the likelihood of conflict between the two opposing sides. This can be achieved either through direct intervention, by facilitating communication and understanding, or indirectly, by creating a deterrent effect that stems from the uncertainty of the ally's position. However, this body of work reveals significant gaps that warrant further investigation. The predominant reliance on a dyadic framework in existing studies limits a comprehensive understanding by not fully accounting for the complexities of mutual causation and the co-evolution between common allies and conflict networks. Such an oversight potentially leads to skewed statistical inferences, mistakenly attributing certain effects to common allies which may not solely emanate from them. Moreover, the focus on formal military alliances as the sole indicator of positive state relationships overlooks the critical influence of informal ties, such as Defence Cooperation Agreements (DCAs). These non-formalized relationships play an essential role in shaping international politics, suggesting that our understanding of positive relations and common allies needs to be broadened to encompass these dynamics.

The conceptualization of defense cooperation community and the role of "community brokers" introduces an innovative avenue to further explore the mechanics of "extended" common alliances. Similar to common allies that are established through direct military alliances, "community brokers" serve a dual function: as intermediaries facilitating communication between states across different clusters and as potential interveners in conflicts. Furthermore, these brokers hold a unique hierarchical position that enables them to rally additional states from various communities as potential mediators, expanding the network of influence beyond direct allies.This nuanced position of "community brokers" suggests that their ability to mitigate conflicts may not be limited to direct connections. Even in cases where two countries do not share a direct link to a broker, the broker's understanding and membership with the communities involved can leverage their unique informational and networked position to reduce conflict tendencies among the focal dyad. I therefore propose a first hypothesis:

Hypothesis 1: *Ceteris paribus, dyads that share "community brokers" are less likely to erupt into conflict.*

Hypothesis 1 posits that, holding other factors constant, "community brokers" exert a constraining influence on inter-communities conflicts. Additionally, the extent of this constraining effect is likely contingent upon the characteristics of the community brokers themselves. Specifically, Firstly, the presence of a higher number of shared community brokers between a dyad is anticipated to amplify the constraining effect on conflict. The logic underpinning this expectation is straightforward: an increased count of mediators enhances the likelihood of successful intervention, as it brings more avenues for mediation and conflict resolution into play. Secondly, the influence of a "community broker" is also believed to vary according to its status on the global stage, particularly when the broker in question is a major power. The premise here is that major powers possess a more substantial capacity to intervene in the affairs of other states, both directly and indirectly. As such, a "community broker" that holds significant international influence is expected to be a more potent mediator, capable of exerting a stronger deterrent effect against the escalation of inter-community conflicts.Therefore, we have

Hypothesis 1.1: *Ceteris paribus, dyads that share more "community brokers" are less likely to erupt into conflict.*

Hypothesis 1.2: *Ceteris paribus, dyads that share major power"community brokers" are less likely to erupt into conflict.*

It's crucial to clarify that the introduction of the "community broker" concept does not dismiss or undermine the well-established "common ally" effect. Instead, my objective is to explore the potential for an "extended common ally effect" that operates across community boundaries. This investigation aims to assess whether the principles that underlie the "common ally" effect in facilitating cooperation and mitigating conflict within a singular community can also extend to a broader, inter-community context through the mediation of "community brokers." By examining this extended effect, the research seeks to deepen our understanding of how alliances and broker relationships beyond direct, traditional ties can influence international relations dynamics, potentially offering new insights into mechanisms for conflict resolution and cooperation enhancement across different geopolitical spheres.

4.2 How community brokers influence the endogenous evolution of GDCN?

A prevalent phenomenon in real-world networks, preferential attachment, suggests that as a network expands, new nodes are more inclined to connect with those already having numerous connections. Kinne (2018) posits that countries with a higher number of connections in the global network not only reveal their credibility but also their openness to engaging in strategically valuable agreements, thus attracting further connections from other states. Essentially, for any given state i, there's a higher likelihood of forming ties with state j if j possesses a higher degree of connectivity. However, the introduction of overlapping communities and "community brokers" into this discussion requires a nuanced examination of network hierarchies. Building on Kinne and Bunte (2020b)'s differentiation between bilateral benefits and network interests, it becomes clear that governments must evaluate how new alliances fit within their broader strategic frameworks, beyond the immediate gains of bilateral partnerships.

Within the realms of overlapping community, "community brokers" serve a dual role. Bilaterally, they act as central nodes within the global defense cooperation network, facilitating beneficial exchanges like information sharing among connected states. Yet, from a network perspective, the vigorous activity of such brokers could potentially disrupt the cohesion within defense communities. States contemplating joining defense cooperative groups or establishing Defense Cooperation Agreements (DCAs) must weigh their strategic goals against the broader implications of such alliances, whether to deter aggression or to advance revisionist objectives. Descriptive analyses reveal that only a select few states have managed to secure a advantageous status in the network hierarchy by being part of multiple communities. For any state i,engaging with highly active "community brokers" poses certain challenges for DCAs. Firstly, the ambiguity stemming from brokers' involvement in multiple communities, especially regarding their stance in conflicts, questions their reliability as allies. This uncertainty may misalign with the strategic goals of state i,particularly if it seeks to consolidate forces with allies for ambitious objectives.

Secondly,the asymmetric power dynamics within defense cooperation networks afford "community brokers" the leeway to prioritize individual interests over the collective needs for policy coordination and group cohesion. The diminished reliance of brokers on any single community weakens the necessity for policy coordination with less influential states, thereby undermining the trust in their security assurances. Lastly, as highlighted by Kinne, the questionable reliability of "community brokers" exacerbates the trust dilemma, given the sensitive nature of DCAs involving intelligence sharing and critical activities. Thus, we have:

Hypothesis 2.1: *Ceteris paribus, state is less likely to establish DCA links with a community broker with a high degree of community centrality*

Finally, when examining the interactions among "community brokers" within the hierarchical framework of global defense cooperation networks, an anticipated dynamic emerges: rivalry for limited positions of dominance. This competitive behavior is rooted in the desire for hierarchical dominance, where each "community broker" aims to maintain or enhance its position within the global defense network. The limited slots for top-tier dominance in these networks mean that brokers in similar positions of influence might view each other more as competitors than potential allies. Therefore, I expect that DCAs are less likely to be established between states that mutually have a high degree of community centrality.

Hypothesis 2.2: *Ceteris paribus, DCA links are less likely between states with high community centrality*

5. Research Design

In this chapter, I present the main empirical methods used to test the above hypotheses.The hypotheses outlined in this paper propose an intricate relationship between two dependent variables: the Defense Cooperation Agreement (DCA) network and the interstate conflict network. This co-evolutionary framework suggests that dynamics within these networks are not isolated but interconnected, influencing each other over time. In the exploration of conflict outcomes, prevalent studies predominantly utilize logistic regression or dynamic network modeling. This research will employ both logit model and dynamic network model to assess the proposed hypotheses. The application of logistic regression models facilitates alignment with extant research, while dynamic network models are employed to tackle the issue of endogeneity. This dual-model approach ensures both comparability and methodological rigor in addressing the research.

5.1 Data and Variables

5.1.1 Dependent Variables

Data on Defense Cooperation Agreements (DCA) networks are sourced from (Kinne & Bunte, 2020b), organized into "dyad-year" unit spanning from 1990 to 2010. In the regression model, the dependent variable is the binary variable $DCA_{ij,t}$, where the variable is assigned a value of 1 if any type of DCA link exists between countries i and j in year t, and 0 otherwise. For the dynamic network model, the dependent variable is represented as an $N \times N$ network matrix $\mathbf{X}$, with N denoting the number of states for each year. A value of $x_{ij,t} = 1$ indicates the presence of any DCA link between states i and j in year t; otherwise, it is 0 .

Similarly, data on the Militarized Interstate Disputes (MIDs) network were derived from the Militarized Interstate Conflict Database (version 5.0). The approach to defining the dependent variable in the regression model mirrors that of the DCA network, setting the binary variable $MID_{ij,t}$ to indicate the presence (1) or absence (0) of a militarized interstate conflict between i and j in the year t. The MID network is analyzed within the dynamic network model as an $N \times N$ network matrix $\mathbf{Y}$, where $y_{ij,t} = 1$ signifies the existence of any MID link between i and j in year t, and 0 indicates its absence.

5.1.2 Network Endogenous Factors

To examine Hypothesis 1, the R-package `Linkcomm` was employed to extract the global defense cooperation community annually from 1990 to 2010 , aiming to indentify "community brokers" who hold memberships in multiple communities within the global network for each year.

For the purpose of testing Hypothesis 1, a binary indicator CB_{ij} was constructed. This variable is assigned a value of 1 when countries i and j are members of different community yet share at least one "community broker," and it is set to 0 in all other instances. To address Hypothesis 1.2, $CBcount_{ij}$ is introduced as a count variable, summing the number of "community brokers" that countries i and j have in common. In relation to Hypothesis 1.3, $CBmajor_{ij}$ is defined to be 1 if the "community brokers" shared by countries i and j encompass at least one of the five permanent members of the United Nations Security Council, and 0 otherwise. Moreover, acknowledging the rivalry between two global powers, the United States and Russia, which has been a prominent feature of the global conflict network throughout the twenty-first century, a binary variable $CBusrus_{ij}$ was formulated. This variable is set to 1 if the "community broker" shared by countries i and j includes both the U.S. and Russia. It is posited that the rivalry between the U.S. and Russia augments the likelihood of conflict between countries i and j, with an anticipated increase in militarized interstate dispute (MID) connections due to the competing influences of the U.S. and Russia.

In the dynamic network model, additional endogenous network variables, including preferential attachment effects and transitivity, are integrated to encapsulate the intrinsic evolution of the network. This approach allows for a more nuanced analysis of the network's dynamics, shedding light on the underlying mechanisms driving its evolution.

5.2 Model

For the logistic regression model, I include dyad fixed effects in the model to capture covariates that do not vary over time in each dyad.

For dynamic network, I use Stochastic Actor-Oriented Model (SAOM) to model the co-evolution of DCA and MID networks. Traditional network analysis techniques are unable to adequately account for temporal dependencies and model the coevolution of node attributes on network ties, a problem that SAOM addresses by being "actor-oriented". Specifically, SAOM models the evolution of a dynamic network as the actions of actors to create, maintain, or terminate ties with other actors, where the decision of the focal actor ("ego") is assumed to be based on the network structure at the time of the decision, as well as the ego's own attributes and those of the other actors ("alter").

The simulation of SAOM proceeds roughly as follows: first, the network changes during the studied time period are decomposed into a number of mini-steps in which an actor creates or terminates an outgoing tie. Subsequently, the rate-of-change function first selects an actor that is likely to change the structure of its ties, which then executes the objective function. The selected actor may add a new edge to another node, remove an existing edge, or leave its edge profile unchanged. From the perspective of node i, the choice of which outgoing dyad k to consider follows the function $f_i(\boldsymbol{\theta}, N) = \sum_k \theta_k \, \mathrm{h}_{ik}(N)$. Finally, SAOM implements statistical inference by comparing simulated networks to real-world networks, with the goal of selecting model parameters to generate simulated networks that are as similar as possible to the observed network(Snijders et al., 2013).

The conventional Stochastic Actor-Oriented Model (SAOM) necessitates that the researcher establish two distinct objective functions: one being a utility function for the nodes, with the nodes' behavior serving as the dependent variable, and the other a network equation, which views the evolution of the network as the dependent variable itself. This study employs the enhanced network co-evolution model formulated by Kinne and Bunte (2020b), which innovatively analyses two network matrices concurrently, assigning a unique utility function to each. Within the context of this research, the focal dependent variables are the Defense Cooperation Agreement (DCA) network (**X**) and the Militarized Interstate Dispute (MID) network (**Y**). This approach allows for a more nuanced understanding of the interplay between these two networks, highlighting their co-evolutionary dynamics.

5.2.1 The DCA Equation

First, for the utility function with the DCA network as the outcome variable is defined as:

$$f_i^X(\mathbf{X}, \mathbf{Y}) = \sum_{h=1} \beta_b^X s_{ib}^X(\mathbf{X}, \mathbf{Y}) \tag{5.1}$$

which determines the creation, maintenance, and termination of DCA network ties. Intuitively, this is a function that simultaneously considers both networks X and Y and their node characteristics as explanatory variables. The right-hand side of the equation is a linear combination of a set of effects. Where s_{ib}^X are the effects that contribute to this utility function, including network endogenous effects, cross-network effects, and both dyadic and monadic covariates. In SAOM, once an actor is given the opportunity to change the network combination of its DCA (i.e., the outcome variable corresponding to that effect function), its actions follow the maximization of that utility function. Such a functional setup allows the DCA network X and the corresponding MID network Y to evolve together in continuous time, with changes in the latter reflected almost instantly in the former and vice versa. For the quantities to be estimated that we are interested in, i.e., the parameters β_b^X corresponding to the individual effects, SAOM uses a simulation method for estimation, whereby an iterative search of the parameter space is performed to find the parameter vectors that make the value of the specified statistic produced by the simulated network approximately equal to the target value. If the algorithm converges well, the deviation between these simulated values and the target value is negligibly small. This simulation process produces $\hat{\beta}_b^X$, the parameters to be estimated.

The DCA equation 5.2 contains cross-network effects, network endogenous effects, and covariates. First, in order to measure the effect of the existence of a link between i and j in the MID network on the existence of a link between two countries in the DCA network. I include:

$$MID_{CrossNet} = s_{i1}^{X} = \sum_{j} y_{ij} x_{ij} \tag{5.2}$$

Put differently, for state i, a DCA link (x_{ij}) with a state j that maintains a MID link (y_{ij}) with state i ought to be given less preference over a relationship with a state j lacking such an x_{ij} relationship with i, given the relatively lower contribution of the former to i 's utility function.

The second set of variables encompasses network endogenous factors. To investigate the impact of country j's community centrality on country i's inclination to build ties with j, I include $CommCentrality_j$ to test Hypothesis 2.Recall from Hypothesis 2 that the higher the centrality of state j in the community, the less credible and dependable it is as an ally, and therefore the less attractive it is as a partner in a DCA relationship. In addition, I also include the two basic endogenous network effects of preferential attachment and transitivity.

5.2.2 The MID Equation

The MID equation also includes a range of cross-network effects to deepen the analysis. Firstly, echoing the structure seen in Equation re $eq : 5 - 2$, DCA_{CrossNet} measures the influence of an existing Defense Cooperation Agreement (DCA) link between countries i and j on the formation of a MID link. Secondly, in order to test Hypotheses 1 through 1.3, the model includes variables CB_{ij}, $CBcount_{ij}$, $CBmajor_{ij}$ and $CBusrus_{ij}$ to test whether and how the existence and attributes of shared "community brokers" affects the propensity for conflict between i and j. It's important to note that the SAOM does not inherently generate functions for these variables.

Finally, both equations include a range of monadic and dyadic control variables. These control variables generally build on Kinne (2018, 2020) and capture economic, political, and military factors that may have an impact on the network of the two dependent variables.

For the monadic covariates, I include $Democracy_{it}$ (whether or not state i is a democracy), per capita gross domestic product $(logged)GDPper_{it}$, $PolityScore_{it}$, the Composite index of National Capability Score $(logged)CINC_{it}$, and Military expenditure per capita $(logged)MilEXPper_{it}$.

For dyadic covariates, I include $BothDemocracy_{ijt}$ (whether i and j are both democracies), $CommonEnemy_{ijt}$ (the number of third-party states with whom i and j fought a MID in the past five years), $(logged)Trade_{ijt}$ (total annual trade flows between i and j), $NATO_{ijt}$ (whether i and j are both NATO member states), $Alliance_{ijt}$ (whether there is a formal military alliance between i and j), $(logged)distance(logged)_{ijt}$ (distance between the capitals of i and j), and the similarity between two states' voting patterns in the United Nations General Assembly $UNGAaffinity_{ijt}$.

6. Results

I initially test Hypotheses 1 through 1.3 utilizing a fixed effects Logit model, with Figure 6.1 delineating the primary outcomes. Notably, the coefficients associated with the $CommunityBroker_{ij}$ variable exhibit significant positivity, corroborating Hypothesis 1. Specifically, for dyads belonging to disparate communities yet sharing at least one Community Broker, the presence of a Community Broker diminishes the probability of conflict emergence between the two nations, that is, the formation of MID linkages. Nevertheless, the coefficient representing the quantity of community brokers does not reach statistical significance. Contrarily, the coefficient's positive valuation suggests an increased probability of conflict with a higher count of shared community brokers, deviating from the initial hypothesis. This phenomenon could be interpreted as the presence of multiple 'community brokers' introducing more potential intermediaries while simultaneously engendering a collective action conundrum regarding third-party interventions, thereby exacerbating the complexity of conflict dynamics within the concerned dyad.

Moreover, diverging from theoretical anticipations, the presence of at least one major power among the community brokers associated with the focal dyad significantly heightens the risk of conflict. This observation aligns with B. K. Lee (2023) theoretical exposition, which posited that, despite the presumed enhanced capacity and propensity of a significant power to intervene, empirical evidence does not substantiate a heightened impact of major powers on the longevity of their associated rivalries. How does one rationalize this outcome? It is posited that the merely 'common ally' framework may neglect the intricacies inherent in major power rivalries. Particularly, if the community brokers connecting the two countries encompass competing superpowers, such interventions rooted in rivalry could inadvertently escalate conflict probability and extend its duration. The markedly positive coefficient tied to the "USRUS" variable furnishes preliminary substantiation for this assertion, suggesting that when the United States and Russia act as brokers within the same dyad, their interventions, driven by rivalry dynamics and supporting opposing factions, may inadvertently fuel conflict inception and escalation.

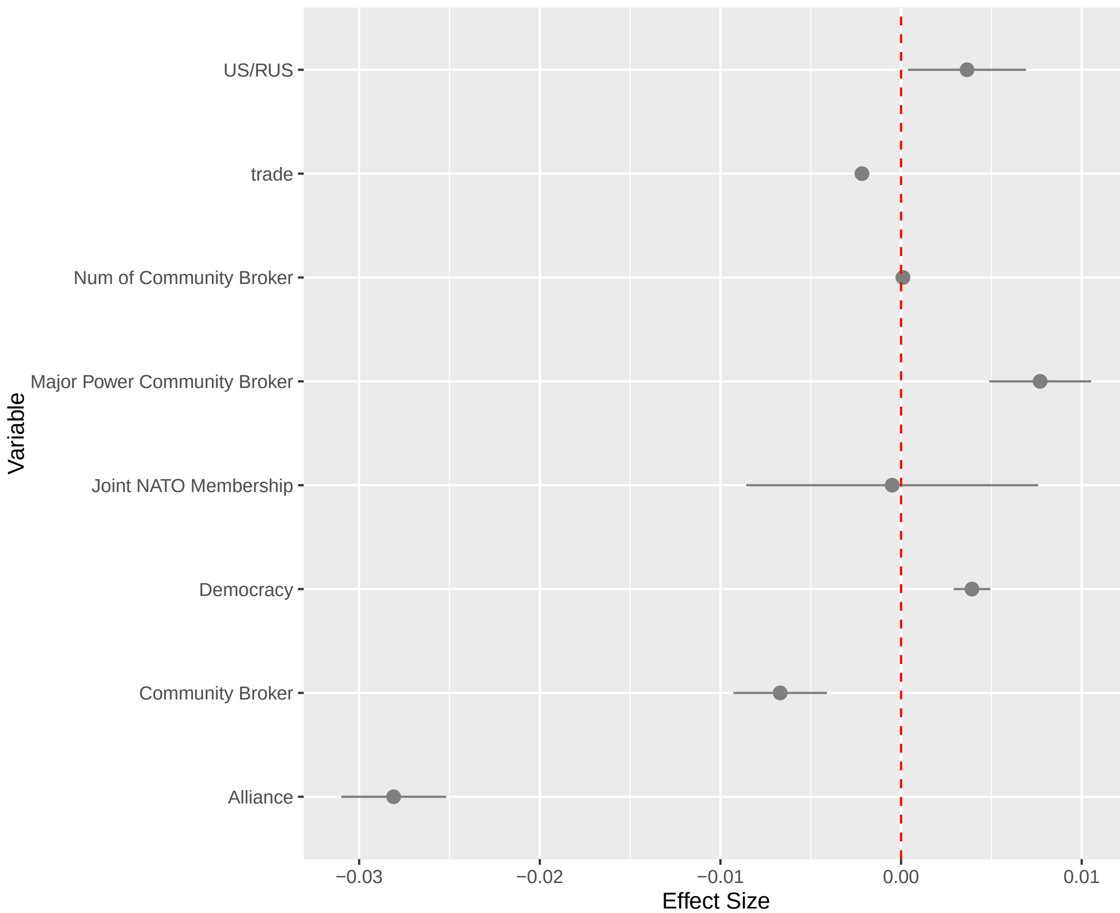

FIGURE 6.1: Correlation of Community Centrality and Degree Centrality

The analysis of the control variables in the model yields noteworthy findings. In alignment with the "trade peace theory," the trade volume between the two nations exhibits a significant and negative association with their propensity towards conflict, suggesting that higher levels of bilateral trade diminish the likelihood of disputes. This outcome reinforces the argument that economic interdependence fosters peaceful international relations. Contrastingly, the presence of joint democracies shows a positive correlation with conflict propensity, an intriguing result that diverges from conventional expectations. Furthermore, the variable representing alliance aligns with general theoretical anticipations, demonstrating a significant and negative correlation with conflict propensity. This indicates that alliances, presumably through mechanisms of cooperation and mutual support, tend to reduce the likelihood of conflict between member countries.

In conclusion, the fixed effects Logit model elucidates that the likelihood of conflict between two countries diminishes when they share at least one "community intermediary". Yet, the dynamics complicate with the incorporation of the number of intermediaries and the involvement of large-country intermediaries. The positive coefficients associated with these variables suggest that an increase in the number of intermediaries may lead to a collective action problem, and the involvement of major powers could heighten conflict propensity due to rivalry interventions. These observations offer partial validation for the Hypothesis 1.

However, regarding Hypothesis 2, which posits the influence of community centrality on the endogenous evolution of Global Defense Cooperation Networks (GDCN), the current "dyad-year" based models fall short in integrating this effect. Kinne (2018) endeavors to incorporate network dynamics, such as Degree, into a Logit model by using the "dyad-year mean of the total Defense Cooperation Agreements (DCAs) signed by i and j in the preceding five years" as a surrogate for the preferential attachment effect. Nevertheless, this approach does not adequately delineate the directionality of network endogenous effects, nor does it accurately reflect how state i, as an individual actor, reacts to state j's network position. Moreover, the fixed effects model, despite its strengths, does not fully resolve the issue of endogeneity. This limitation underscores the complexity of modeling international relations, where the intertwined nature of state interactions and network dynamics poses significant analytical challenges. Therefore, I use SAOM to test Hypothesis 1 against Hypothesis 2. The data results are displayed in Tables 6.1 (DCA Network) and 6.2 (MID Network).

Examining the variables pertinent to Hypothesis 1 reveals that the expectation—that states sharing "community brokers" would exhibit a reduced likelihood of conflict—is not corroborated by the data presented in Table 6.2. Specifically, while the coefficients for the CommunityBroker, NumCommunityBroker, and MajorCommunityBroker variables align with theoretical predictions in their negative orientation, they fail to achieve statistical sig-

Table 6.1: SAOM: The DCA Network

	Betas	SEs	Conv.
Degree (density)	-1.603***	(0.061)	-0.006
Transitivity	0.263***	(0.047)	0.002
Degree of *j*	0.049***	(0.004)	-0.005
Network-isolate	4.275***	(0.276)	-0.005
(logged)Trade	0.049***	(0.013)	0.021
NATO	-1.161***	(0.151)	0.033
(logged) Distance	-0.422***	(0.026)	-0.031
Alliance	0.477**	(0.182)	0.029
UNGA Affinity	-0.208***	(0.058)	-0.034
Joint Democracy	0.239**	(0.078)	-0.007
Polity IV of *j*	0.022**	(0.007)	0.014
(logged)GDPcap of *j*	-0.028	(0.023)	0.001
(logged)CINC of *j*	0.201***	(0.056)	0.01
(logged)MilPer of *j*	0.089†	(0.053)	0.006
Community Centrality of *j*	-0.041†	(0.022)	0.001
Community Centrality x Community Centrality	-0.009*	(0.004)	0.036
MIDCrossNet	-0.823	(0.503)	0.051

$^{\dagger}p < 0.1, ^{*}p < 0.05, ^{**}p < 0.01, ^{***}p < 0.001$. Standard errors in parentheses.

nificance at conventional levels of testing. Furthermore, the "USRUS" variable, which was theoretically posited to increase the propensity for conflict within a dyad, similarly did not yield a statistically significant effect. These findings present a nuanced narrative; although the fixed effects logit model initially suggested a constraining role for "community brokers" against conflict emergence, this effect dissipates when considering the co-evolution of Defense Cooperation Agreement (DCA) and Militarized Interstate Dispute (MID) networks. This discrepancy highlights the complexity of international relations dynamics and underscores the need for further investigation into how and under what conditions "community brokers" might influence conflict, considering the multifaceted nature of state interactions and network evolution.

Contrasting with the findings related to Hypothesis 1, the finding in Table 6.1 lends support to Hypothesis 2. The analysis reveals a significant negative coefficient for the variable "Community Centrality of j" at the level of significance of 10

Such findings not only bolster the theoretical argument made in Hypothesis 2.1 but also

Table 6.2: SAOM: The MID Network

	Betas	SEs	Conv.
Degree (density)	-6.226***	(0.338)	-0.055
Transitivity	0.11	(0.125)	-0.011
Degree of *j*	0.104***	(0.014)	-0.02
Network-Isolate	1.92***	(0.377)	0.032
UNGA Affinity	-0.806***	(0.19)	0.01
(logged)Trade	-0.094**	(0.033)	-0.03
NATO	-2.237**	(0.766)	0.006
(logged) Distance	-1.305***	(0.079)	0.03
Alliance	2.722***	(0.765)	-0.021
Joint Democracy	0.159	(0.3)	0.031
CommunityBroker	-0.376	(0.361)	-0.006
NumCommunityBroker	-0.005	(0.018)	-0.01
MajorCommunityBroker	-0.283	(0.425)	-0.005
USRUS	0.379	(0.544)	0.009
Polity of *j*	-0.1***	(0.021)	0.052
Polity x Polity	-0.007***	(0.001)	-0.011
(logged) GDPcap of *j*	0.096	(0.08)	0.032
(logged) GDPcap x (logged) GDPcap	0.18***	(0.031)	-0.051
(logged)MilPer of *j*	-0.264**	(0.093)	-0.02
(logged)CINC of *j*	0.792***	(0.179)	-0.03
(logged)CINC x (logged)CINC	0.087*	(0.036)	-0.033
DCACrossNet	-0.04	(0.248)	-0.031

$^{\dagger}p < 0.1, ^{*}p < 0.05, ^{**}p < 0.01, ^{***}p < 0.001$. Standard errors in parentheses.

underscore the intricate interplay of rivalry and centrality within the GDCN. It emphasizes the role of "community brokers" and their centrality in shaping the landscape of global defense cooperation, highlighting the competitive nature of establishing ties within a network characterized by strategic interests and geopolitical considerations.

The mixed outcomes regarding endogenous network effects within the model shed light on the intricate dynamics of state interactions within Defense Cooperation Agreement (DCA) and Militarized Interstate Dispute (MID) networks. Specifically, the analysis reveals that node connections between state dyads do not manifest cross-network effects. In essence, the establishment of a DCA link between states i and j does not influence their likelihood to form a MID link, and vice versa, suggesting that defense cooperation agreements and conflict engagements probably operate within distinct spheres of interaction without direct influence on one another. Conversely, the "Degree of (j)" variable showcases a significant and positive correlation with the formation of links in both networks, underscoring the principle of "preferential attachment." This phenomenon indicates a strategic preference among states to form links with those already well-connected within the network. Such behavior reinforces the importance of network position and connectivity in international relations, where states assess the existing ties of potential partners or adversaries in their strategic decisions.

Moreover, the Transitivity coefficient reveals a divergence between the two networks. Within the DCA network, a significant positive effect suggests that states are more inclined to establish defense cooperation links with "friends of friends," highlighting the role of existing network structures in fostering new connections. This "friend of a friend" mechanism supports the concept of network closure, where interconnected nodes facilitate the expansion of links through shared connections. In contrast, the Transitivity effect in the MID network is constrained, indicating that the dynamics of conflict engagements do not follow the same pattern. The limited transitivity within the MID network may reflect the complex nature of conflict relationships, where strategic considerations and geopolitical factors outweigh the simple network principle of shared connections.

Finally, the analysis of covariates within the DCA and MID networks reveals patterns that align well with theoretical predictions about the dynamics of international relations. In the DCA network, the positive influence of higher dyadic trade, the existence of alliances and co-democracy status, elevated polity indices, and Comprehensive National Power (CINC) scores on the formation of new ties is evident. These factors underscore the significance of economic interdependence, political alignment, and mutual democratic governance as foundational pillars for establishing defense cooperation links between states. This concordance with theoretical expectations illustrates how shared values, strategic interests, and power dynamics drive the formation of cooperative relationships in the international arena. Conversely, within the MID network, the presence of higher United Nations General Assembly (UNGA) Affinity, common NATO membership, and increased dyadic trade appears to mitigate the risk of bilateral conflict. The reduction in conflict likelihood due to these factors supports the notion that shared interests and cooperative frameworks contribute to international peace and stability.

The exploration of interaction terms within the MID network further illuminates the nuanced relationship between democracy levels and national power on conflict dynamics. Specifically, the negative effect of the "Polity x Polity" interaction indicates that dyads consisting of high-level democracies are less prone to conflict, affirming the democratic peace theory which posits that democracies are less likely to engage in wars with each other. On the other hand, the positive effect of "CINC x CINC" interaction suggests that pairs of countries possessing greater comprehensive national power are more inclined towards conflict, likely reflecting competitive dynamics and power rivalries on the global stage.

These findings not only align with theoretical frameworks but also provide empirical insights into the complex interplay of economic, political, and strategic factors in shaping the landscape of global defense cooperation and conflict. The differential impacts of these covariates across the DCA and MID networks highlight the multifaceted nature of state interactions, where cooperative and conflictual relations are influenced by a diverse array of determinants.

7. Conclusions

The exploration of global defense cooperation networks (GDCN) through this study emphasizes the complex and interconnected nature of state interactions within the international system. By delving into the nuanced concepts of overlapping communities and "community brokers," the research illuminates the intricate ways through which states navigate the global network, shaping and being shaped by the dynamics of international security.

Overlapping communities within the GDCN highlight the reality that states often embody multiple roles and affiliations, challenging the notion of clear-cut, isolated groups within international relations. This multiplicity of community identities underscores the fluidity and complexity of global alliances and enmities, where states are not merely confined to singular, exclusive associations. The identification of "community brokers" — states that bridge these overlapping communities — introduces a critical lens through which to assess the mechanisms of global security dynamics. These brokers, by virtue of their informational superiority and strategic positioning, have the potential to act as pivotal influencers within the network, moderating inter-community conflicts and guiding the evolution of security cooperation. The study proposes two key mechanisms through which "community brokers" exert influence: firstly, by leveraging their informational advantage to act as a deterrent to conflict between distinct communities; and secondly, through their unique position within the network, which allows them to shape the trajectory of defense cooperation and security production. However, the possession of such hierarchical power also introduces a paradox; "community brokers," by being embedded in multiple communities, may dilute their allegiance to any single group, potentially undermining the cohesion and mutual trust necessary for effective security partnerships.

Empirical findings from the application of fixed-effects regression models and dynamic network modeling present a nuanced picture. While regression analyses suggest a constraining role of "community brokers" in reducing inter-community conflicts, with the incorporation of the DCA and MID networks' co-evolution, the Stochastic Actor-Oriented Model

(SAOM) analysis reveals that "community brokers" have only limited ablility to explain interstate conflicts. Instead, the SAOM analysis reveals a community hierarchy in global defense cooperation networks: "community brokers" are less likely to be the target of new DCA linkages, and rivalry among "community brokers" around structural advantageous positions makes them less likely to to establish DCA links with each other.

This study, through the introduction of overlapping communities and "community brokers," sheds light on the intricate dynamics of complex interdependencies that characterize the international security landscape. These concepts have unraveled new layers of understanding regarding how states interact within the global arena, highlighting the role of strategic intermediaries in shaping the patterns of cooperation and conflict.

Methodologically, the divergent outcomes produced by the regression model and the dynamic network modeling underscore the necessity of a cautious approach when interpreting results derived from traditional dyadic analytical frameworks. The variance in findings between models emphasizes the complexity of international relations and the potential limitations of conventional methodologies in capturing the nuanced interplay of global defense cooperation networks.

Looking forward, this research opens avenues for further scholarly exploration into the utility of the community concept within international politics. Future studies are encouraged to delve deeper into the endogenous evolutionary mechanisms of cluster overlap, offering potentially groundbreaking insights into the formation, evolution, and influence of communities in the international system. By pushing the boundaries of how we conceptualize and analyze state behavior and inter-state relations, researchers can uncover new theoretical and empirical understandings of the forces that drive global security dynamics.

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