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### Lethal Connections: The Determinants of Network Connections in the Provisional Irish Republican Army, 1970-1998

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# **Lethal Connections: The Determinants of Network Connections in the Provisional Irish Republican Army, 1970–1998**

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*Using stochastic methods we illustrate that the Provisional Irish Republican Army's (PIRA) network is clustered along three primary dimensions: (a) brigade affiliation, (b) whether the member participated in violent activities, and (c) task/role within PIRA. While most brigades tended to foster connections within the brigade (that is, "closure"), the tendency to do so varied across the organization. Members who engaged with violent activities were far more likely to connect with each other; in later periods there is polarization into those who engage in violent activities and those who do not. Across brigades, those who engage in a particular task and role (improvised explosive device [IED] constructor, IED planter, gunman, robber/kidnapper/drug smuggler/bijacker) are more likely to connect with others who do the same task or play the same role than with other members who fulfill other roles. Standard forms of homophily (that is, the tendency to make connections with people who are similar in terms of demography or status) play a very*

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*weak role in explaining which members interact with one another. Finally, our analysis illustrates clear patterns of relational change that correspond to changes in the formal structures that PIRA's leadership promoted.*

*KEYWORDS* conflict, network analysis, terrorism

Since the earliest work on terrorist movements, two dominant images of network connections between movement members prevailed. One projects terrorist organizations as comprised of small, possibly “leaderless,” secretive cells of individuals who keep to themselves and seek to avoid detection (Arquilla 1999; Arquilla and Ronfeldt 2001, 2002; Tsvetov and Carley 2005; Tucker 2001). A more recent image is of cells that are loosely connected yet centrally coordinated, with potentially a hierarchical structure at the highest levels (Mishal and Rosenthal 2005). Additionally, Arquilla and Ronfeldt (2001) suggested that other hybrid structures may be feasible. While recent efforts have been made to model the most appropriate structure (see Enders and Su 2007; Lindelauf, Borm, and Hamers 2009), we know of no other data set that comprehensively captures data on the core membership of a terrorist organization and analyzes the structures *actually* formed among the members. This paper attempts to fill that gap. Below we present a preliminary analysis of data on over 1,384 active Provisional IRA (hereafter PIRA) members between 1970 and 1998.

Our analysis focuses on several exploratory questions: Why do PIRA members have relationships with some members of the movement but not others? What extent do socioeconomic factors like age, education, and marital status influence relationship formation? How integral are formal structures, such as brigades, to relational formation? Are there strong tendencies toward closure and clustering in these networks, or do they tend toward a hierarchical structure of sorts? Finally, to what extent are certain types of activity—for instance, improvised explosive device (IED) construction or planting—related to the propensity to make connections? We will return to the question of IED activity throughout this paper, as our data was constructed to aide in the study of PIRA's use of IEDs, which long predated the popular familiarity with the term during the U.S. occupation of Iraq (Gill, Horgan, and Lovelace 2011).

Enders and Su (2007) and Lindelauf, Borm, and Hamers (2009) suggest that structural changes in terrorist groups may reflect changes in counterrorism tactics. To account for this, we present analyses from four distinct “phases” of the Northern Irish conflict that correspond to key changes in PIRA's strategy and tactics. For each phase we have created exponential random graph (ERGM) models of the social network data collected for the period, allowing us to consider both the points of continuity in structure over time and causes for dynamism in structure.

In order to understand who connects to whom within a terrorist organization, we build a number of hypotheses based on a series of theoretical perspectives on network connections within licit organizations. Chief among these theoretical perspectives is homophily—that is, the preference for relationships with those who are (more or less) similar across a number of demographic, status, or affiliation variables, a tendency for which is found in virtually all social networks (Ibarra 1992; McPherson, Smith-Lovin, and Cook 2001). Additionally, research on “dark networks” (Milward and Raab 2002) suggests a need for combining closure and hierarchy to avoid detection to remain part of a coherent effort. Research on licit activity has long demonstrated that complex undertakings—for instance, the construction of IEDs or the implementation of coordinated attacks—may require tighter coordination (Thompson 1967) and thus more tightly connected “clusters” in networks to complete them successfully. Finally, though “orthodox” social network theorists have long touted the importance of viewing networks as determinative of behavior, recent stochastic work on social networks emphasizes the need to flip the causal arrow in the other directions—behavior as a determinant of network structure rather than network structure being determinant of behavior (Snijders, Steglich, and Schweinberger 2007). These theoretical drivers of network behavior inform a series of hypotheses regarding the drivers of structural features in PIRA’s network for each the phases of the conflict. The hypotheses are tested against a unique data set of 1300+ PIRA members. While there has been much theorizing about terrorist organizational structure, this is the first study to empirically measure how network connections were formed and changed over time due to situational and organizational factors.

## PIRA’S STRATEGIC AND ORGANIZATIONAL CHANGES

In harmony with recent research on the evolutionary nature of terrorist tactics and networks (Enders and Su 2007; Enders and Sandler 1993; Lindelauf, Borm, and Hamers 2009; Sandler and Enders 2002), we divided PIRA’s activities into four distinct phases with both characteristic activities and characteristic “aspirational” structural features. That is, PIRA, like legitimate organizations, sought to create a particular set of formal reporting structures that could be represented on an organizational chart. However, also like legitimate organizations, the formal structure was paired with an informal structure that helped to overcome inherent weaknesses, irrationalities, and impossibilities of imposing an ideal structure on an actual living, breathing organizational enterprise. The degree to which PIRA realized those structural aspirations is one question for this study. The four phases are primarily characterized by critical junctures in PIRA’s history that led to a change in

strategy, tactics and structure (Bowyer-Bell 2000; Coogan 2002; English 2003; Moloney 2002; Patterson 1997; Smith 1997; Taylor 1997). Indeed, previous research has shown these critical junctures also led to behavioral changes for PIRA including who was recruited (in terms of age and geographic spread for example) (Gill and Horgan 2013), how IED attacks were undertaken (Gill and Horgan 2012) and the group's propensity to engage in IED attacks (Gill, Horgan, and Piazza n. d.) and lethal attacks (Asal, Gill, Rethemeyer, and Horgan in press).

The first phase encapsulates the period 1969–1976. Here, PIRA developed from a ragtag bunch of urban guerrillas to an Army-like structure with various brigades, battalions, and companies. Each unit became responsible for specific geographical combat areas. Indiscriminate violence by all sides of the conflict marked this period—the most defining moment of which was “Bloody Sunday” when the paratroop regiment of the British Army shot and killed 13 innocent civil rights marchers. This was an unprecedented propaganda coup for PIRA and led to mass recruitment and mobilization. Civilian fatalities attributed to PIRA also peaked during this phase and included the events of ‘Bloody Friday’ where, in the space of under two hours, 22 IEDs killed 9 (6 civilians, 2 British soldiers, and 1 member of the Ulster Defence Association) and injured 130.

During phase one, PIRA's strategy sought to quickly force British troops out of Northern Ireland by inflicting a high death toll and substantial economic costs in an attempt to sway British public opinion against maintaining the union with Northern Ireland. By 1977, PIRA's plans became more long term and they started plotting a much longer war of attrition that eventually led to an increased dual emphasis upon mainstream political mobilization through their political wing, Sinn Fein in parallel with a tactical, increasingly discriminate “armed struggle.” The urge for this change was borne out of a mixture of improved British intelligence, war weariness, and attrition. Facing these problems, PIRA decided a structural change was required that involved moving from an “outmoded pattern which was proving susceptible to penetration” (Coogan 2002:465). Phase two (1977–1980) therefore embodies the years of PIRA's structural change. The blueprint—entitled “Staff Report”—for this structural change was seized from leading PIRA member Seamus Twomey in December 1977. The Staff Report's authors noted the PIRA ranks “are burdened with an inefficient infrastructure of commands, brigades, battalions and companies. . . We recommend reorganization and remotivation, the building of a new Irish Republican Army.” Emphasizing a return to secrecy and stricter discipline, the report created new departments within the organization (including Education Officers whose job entailed providing anti-interrogation lectures in conjunction with indoctrination lectures), outlined the new cell structure for urban based operations and the command and functional structures of these new cells, specified the new role for PIRA's

female and youth wings, instituted a new auxiliary unit to take over policing duties in Catholic strongholds, and promoted the political wing *Sinn Féin* to the forefront (Coogan 2002:465–467). Together, these changes placed far less emphasis on the quantity of Volunteers and far more emphasis on secrecy and discipline (Horgan and Taylor 1997). Almost instantly, the effects of the structural changes were significant. Within a year, 465 fewer charges for paramilitary offences occurred (Smith 1997:145).

Phase three (1981–1989) was a period of growing politicization of the Republican movement after the Hunger Strikes. In total, 10 Republicans died on hunger strike in 1981. PIRA's Bobby Sands was elected to Westminster after winning a by-election while on hunger strike. Sympathy for PIRA began to rise again, and was largely channeled toward the rise of PIRA's political wing by organizational elites.

Phase four (1990–1998) incorporates the years of negotiations and the march toward the final cease-fire and the Good Friday Agreement that symbolized for many the end of the Northern Ireland conflict.

## THEORY

Though the determinants of social network structure have been a focus of attention in social network analysis since its inception, stochastic techniques have made it easier to disentangle the effects of node-level characteristics and dependencies within the data. Our approach focuses on three general areas of theoretical concern: trust and its relationship to homophily, the influence of behavior on the proclivity to make connections, and finally roles and tasks and their tendency to subdivide networks.

### Homophily

Homophily is usually defined as similarity between two nodes in a network. Since Aristotle, scholars have noted that “birds of a feather flock together” (McPherson, Smith-Lovin, and Cook 2001:417). McPherson, Smith-Lovin, and Cook (2001) outline five broad factors that promote homophily; geography, kinship, organizational affiliation, occupational affiliation, role relationships, and cognitive processes—including shared knowledge (Carley 1991). Network members tend to prefer homophilous relationships because “interpersonal similarity increases ease of communication, improves predictability of behavior, and fosters relationships of trust and reciprocity” (Ibarra 1993:61). Nooteboom (2006) also found that there is likely a broader degree of “trustworthiness” endowed in any relationship that exists between members of a dyad (Nooteboom 2006:250). Homophilous relationships are a type of heuristic: when there is ambiguity and uncertainty in the environment, individuals seek to ameliorate it through the shortcut of relationships

with similar others with the goal of creating homogenous, easily predicted networks. When in doubt—or in peril—individuals prefer relationships with similar others.

Because we are focusing on a relatively homogenous organization, some forms of homophily cannot be easily probed (for example, differences in ideology or religious affiliation). Instead, we focus upon demographic characteristics and organizational affiliation. With respect to demographic characteristics, we generally expect that two members are more likely to have a relationship if they are more similar in terms of marital status, educational attainment, and age at recruitment. Similarly, “brigades” were used as an organizing structure throughout the period under study. Sharing membership in one of these subunits is expected to increase the probability that two members are connected.

H1: *Members of the same gender are more likely to connect with one another.*

H2: *Ties are more likely between two members as their age at recruitment is more similar.*

H3: *If two members both attended a university they are more likely to share a connection.*

H4: *Members recruited during the same phase of the conflict are more likely to share a connection.*

H5: *Members are more likely to make connections within their “home” brigade than between brigades.*

The first five hypotheses conform to general findings regarding “vectors” for homophily in most social settings, and there is no reason not to expect them to hold in the context of terrorist organizations. The last two are more specific to PIRA’s case. Hypothesis 4 suggests there may be cohort effects. That is, those who are recruited at the same time tend to form relationships during their early training and socialization. There may also be cohort effects that arise from being recruited during different phases of the conflict. Brigades are clearly a lasting organizational “foci” (McPherson, Smith-Lovin, and Cook 2001) for PIRA that may have structured all relationships within the movement. While organizational foci are a general component in homophily, PIRA’s brigade structure is specific to it.

### Behavioral Similarity

As noted before, most social network research seeks to explain how networks structure behavior. However, the work of Snijders and colleagues refocused on the possibility that behavior shapes network choices. Snijders in particular has demonstrated through “co-evolution” modeling that, stochastically speaking, behaviors are often implicit in network structure (Mercken

et al. 2010).<sup>1</sup> Nagar, Rethemeyer, and Asal's work on the Jewish Underground (forthcoming) also demonstrates the degree to which terrorist movements can be bifurcated by the decision to engage or not engage in violence as part of the movement. Further, Horgan and Taylor depict two types of PIRA member, those who are operational and those who are nonoperational. While operational members engage in violent attacks, nonoperational members provide the support roles of storing and transporting weapons and providing safehouses (Horgan and Taylor 1997:3). For these reasons, we also expect PIRA's network to be affected by whether a member chooses (or is assigned) to participate in violent activities or not.

PIRA was also split along operational areas on a macroscale. Those under the leadership of Northern Command typically carried out their duties in the six counties encompassing Northern Ireland and the five border counties belonging to the Republic of Ireland. In contrast, those under Southern Command leadership operated within the other 21 counties of the Republic of Ireland and typically carried out logistical support operations such as training, funding, and the storage and movement of weapons.

H6: *Members that engage in violence are more likely to have relationships with others who engage in violence.*

H7: *Members who eschew violence or are not assigned to participate in violent activities are more likely to have relationships with others who do not engage in violence.*

H8: *Members who engage in violence outside Ireland are more likely to have relationships with others who engage in violence outside Ireland.*

## Roles and Tasks

The final set of factors is the importance of roles and tasks to network connections. Thompson (1967) noted that organizations choose different organizational forms depending on the nature of production. Thompson outlined that the production of simple devices may be accomplished through routinized procedures with minimal interactions among workers but creation of complex devices and materials require greater interaction. This fundamentally organizational insight has individual level implications for relationships among terrorist organization members. This study particularly focuses upon IED actors for a number of reasons. First, a hallmark of PIRA's ability to survive and adapt over time was its substantial technical acumen in its IEDs (Gill, Horgan, Hunter, and Cushenbery in press). Second, evidence suggests that PIRA's structural change indirectly impacted upon the commission of

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<sup>1</sup>Due to the uneven length of the phases, coevolution modeling for this data is not possible. As we will note later, this is a limitation of our data and findings.

IED attacks but not shooting attacks (Gill and Horgan 2012). Third, the growing threat of IEDs worldwide necessitates a more thorough analysis of IED networks. Finally, bombings and complex attacks usually require extensive interaction between team members compared to other terrorist attack types that require less planning and expertise (Johnson and Braithwaite 2009). We therefore expect that individuals involved in the IED process would be organized as highly integrated teams in order to gain the benefits of intensive interaction in the face of greater complexity. Networks involving other inherently more complex activities (for example, kidnapping, hijacking, bank robbery, or drug smuggling) are also more likely to be tightly interconnected, as none of these activities are easily accomplished alone.

Horgan and Taylor (1997) depict PIRA's command and functional structure as compartmentalized across strategic, tactical, and organizational domains. While the Army Council dictates overall military strategy and has the power to veto various military tactics and operations, another component of PIRA's structure, the General Headquarters (GHQ), is "responsible for the overall maintenance and conduct of PIRA activities" (Horgan and Taylor 1997:9). GHQ consists of 10 separate departments including Quartermaster, Security, Operations, Foreign Operations, Finance, Training, Engineering, Intelligence, Education, and Publicity. These departmental structures in combination with Northern and Southern Command "have as their collective role the establishment, control, direction, and maintenance of the Provisional IRA's Active Service Unit" (Horgan and Taylor 1997:18). Active Service Units (ASUs) are composed of individuals who directly engage in violent military operations. As Horgan and Taylor (1997:20) note, ASUs "are generally trained and designed to specialize in *specific* tasks, e.g. robberies, shootings, bombings, internal security, intelligence-gathering on specific targets, etc. . . . This apparent 'specialisation' is an effective tactical and 'economical' aspect of PIRA functional strategy." These reasons lead to the following hypotheses:

- H9: *Members who construct IEDs are likely to connect to other IED constructors.*
- H10: *Members who plant IEDs are likely to connect to others who plant IEDs.*
- H11: *Members who engage in bank robbery, kidnapping, hijacking, or drug smuggling are more likely to connect with others who engage in these activities.*
- H12: *Members who act as gunmen are no more or less likely to form connections with other gunmen.*

### Trust but Verify

Finally, building structures within the movement to contain the damage from betrayal should still be an important feature of network structure. Network analysts have focused on the utility of relatively closed network structures

(Coleman 1988, 1990; Coleman and Hoffer 1987). Within such structures one may monitor behavior and compliance more easily—all members know all other members and can quickly share information about bad, and good, behavior (Burt 2005). A number of terrorism scholars (Arquilla 1999; Arquilla and Ronfeldt 2001, 2002; Tsvetovat and Carley 2005; Tucker 2001) have sought to put a finer point on the nature and types of structures that might be prevalent and about how much closure is sufficient. We remain agnostic about these questions, preferring instead to let the data speak to us. Our expectation, however, is that a relatively clustered structure should prevail.

H13: *PIRA networks in all phases should demonstrate a tendency toward clustered network structures.*

## DATA AND METHODS

This study draws on both longitudinal and cross-sectional data collected at the International Center for the Study of Terrorism, Pennsylvania State University. From this data we derive network structures and the nature of dependence within them. The PIRA network comprises the following four types of relationships: (1) involvement in a PIRA activity together, (2) friends before joining PIRA movement, (3) blood relatives, and (4) related through marriage. We treated each relation as a tie and coded whether a tie exists between two members or not. Thus, our PIRA networks have, conceptually and technically, binary and symmetric relations between members.

In our initial pass through the data we identified over 5,000 potential nodes. However, through repeated refinements of our data coding schemes we reduced this list to approximately 2,500 that had known relationships. Then efforts were made to exclude individuals who had sympathized with PIRA but were not active in the movement. Through this process we identified a final set of 2,054 PIRA members.

Concurrently, we collected sociological information of members, such as gender, age, marital status, recruiting age, education (that is, attending university), brigade memberships, non-/violent characteristics, role-related characteristics—senior leader, IED constructor, IED planter, and gunman—and task-related characteristics (that is, foreign operation tasks, and involvement in bank robbery, kidnapping, hijacking, and drugs).

In our first pass through the data we collected sociological data on roughly 1,300 of the 2,054 members. Data were available for the un-coded individuals but because the original “actor dictionary” was developed to include only key PIRA actors and their connections, we triaged the missing individuals for whom data was uncollected, concentrating on those that appeared in multiple periods and had at least 5 “connections,” here defined

as the sum of incoming and outgoing ties. Our final data set included sociological data on 1,384 of the 2,054 members (67.4%). The nodes for those we did not collect sociological data are primarily isolates (no connections), “pendants” (one connection), “dumb bells” (two individuals that are connected to one another but to no one else), and low-centrality nodes. While these individuals are undoubtedly important and were perhaps effective actors within PIRA because of their relative isolation, our primary concern in this exploratory study is of the actual core network. While our data is not complete, we believe the network data is comprehensive with respect to the most important and highly connected members—what could be termed the core PIRA members.

To see how these members are connected within the networks in detail, we omitted actors lacking sociological data, and actors completely isolated from others within the networks. Our rationale is that the former cannot provide much explanation about their attributes on networking behaviors and the latter is effectively not part of the network. Table 1 provides summary statistics on the PIRA network for each Period.

## MODELING

Fundamentally, we want to know what factors make it more or less likely a tie will exist between two members of the network. We used an Exponential Random Graph Model (ERGM) in order to account for various sources of dependence in our data, but most especially dependence deriving from broad social structural tendencies or “pressures” in this domain—for instance, the need for a friend of a friend to also be a friend if one is to avoid infiltration by counterterrorism authorities. Our model, thus, includes both structural variables (for example, preference for alternating k-stars and k-triangles, which indicate clustering) and those related to homophily (that is, the tendency for members of PIRA to connect with others who share certain characteristics). First we provide a brief introduction to Exponential Random Graph Models (ERGM).

**TABLE 1** Deletion Rate Over Identification Processes for the IRA Networks for Each Period

Periods	Number of members	Number of members with sociological data	Number of members with sociological data after deleting isolates
Period 1	763	(49.80% deletion) → 383	(12.79% deletion) → 334
Period 2	419	(32.22% deletion) → 284	(8.45% deletion) → 260
Period 3	897	(37.68% deletion) → 559	(5.90% deletion) → 526
Period 4	631	(35.66% deletion) → 406	(9.60% deletion) → 367

## ERGM

The nonindependence of observations in social network data causes conventional statistical inference to underestimate the true sampling variability (Wasserman and Faust 1994) and thus generate parameters that are biased and inefficient. A number of researchers proposed using an ERGM, also known as a  $p^*$  model, to overcome the inherent issue of dependence (Robins, Pattison, et al. 2007; Frank and Strauss 1986; Pattison and Wasserman 1999; Robins, Pattison, and Wasserman 1999). We utilize Frank and Strauss' (1986) variant of ERGM, a Markov random graph model which proposes that a random graph of a particular network follows a Markov graph when the probability of ties between disjoint pairs of actors are random (that is, independent) given the rest of the graph consisting of certain conditionally dependent ties (that is, a tie from  $i$  to  $j$  is *conditionally dependent*, only on other possible ties involving  $i$  and/or  $j$ ) (Robins, Pattison, et al. 2007).

Recent advances in Markov Chain Monte Carlo maximum likelihood estimation (MCMCMLE) allow us to obtain more accurate parameter estimates through a simulation technique (Robins, Snijders, et al. 2007). Here, we used *Simulation Investigation for Empirical Network Analysis* (also known as SIENA), an open source software package that relies on the MCMCMLE technique, to analyze our sociometric data (for an introduction to stochastic social network analysis, see Snijders 2001; Robins, Snijders, et al. 2007; Snijders 2002, 2005; Snijders and Duijn 2002). We also used UCINET (Borgatti, Everett, and Freeman 2002) to calculate deterministic statistics and NetDraw (Borgatti 2002) to create network visualizations.

## Modeling Procedure

After parameters are generated through a simulation process,  $t$ -ratios for each are generated to assess the degree of fit between the model and the actual data. A sufficient model has little or no divergence from the actual data, so we actually wish to find  $t$ -ratios that are as close to zero as possible (that is, the actual value and the modeled value should be statistically indistinguishable from one another). If the model parameters'  $t$ -ratios approach zero, then the model is said to have "*converged*" sufficiently to trust the results. The models reported in Tables 2, 3, 4, 5, and 6 have  $t$ -ratios less than 0.1, which experience indicates is an acceptable degree of convergence (Snijders et al. 2007).

Second, the goodness-of-fit of each model is examined using SIENA (for more detailed information about interpretation of goodness-of-fit of an ERGM, please see Snijders et al. 2007). The joint goodness-of-fit tests for all models in Tables 2, 3, 4, and 5 were significant at 1% level, which indicates that these models fit the PIRA networks very well.

Third, each parameter is then assessed as to whether each variable has explanatory power in the model. Here, a series of goodness of fit tests with one degree of freedom are run for each parameter. The threshold of significance is the standard 5% or 10% levels. Variables were repeatedly added and removed through an exploratory and iterative model selection process. As a result, the final models are presented in Tables 2, 3, 4, and 5. The procedure also generates a set of standard errors that allow for calculation of “traditional” *t*-ratios to assess the statistical significance of each variable.

## FINDINGS

Our analysis finds that while all four periods are somewhat structurally idiosyncratic, there are a number of regularities, including several dimensions of homophily, the importance of violent activity as a shaper of structural relationships, and the salience of brigades and role/task structure to relationship formation and maintenance. Our modeling also validates past findings of Horgan and Taylor (1997) by discovering major structural evolutions.

The stochastic results using SIENA account for homophily arising from similarity across demographic characteristics, brigade membership, proclivity to engage in violence, and roles or tasks individuals assume or undertake. SIENA’s results are similar to a multinomial probability model, so the parameter estimates should be treated like other logit models—the sign and significance may be directly interpreted but the magnitude may not be. However, SIENA differentiates two effects by using unidirectional and symmetric data—actor and similarity—for each attribute, such as gender, whereas, the three effects—ego, alter, and similarity—for each attribute are differentiated by employing directional and symmetric data. Actor related covariates indicate that actors with a high value for an attribute (for example, members who are violent are coded as 1, while others are coded as 0) tend to make ties more quickly than others. Similarity-related covariates indicate that actors tend to have ties with similar actors more often—for instance, there is a tendency for women to create relationships with other women rather than with men.

### Period 1

Table 2 reports the final model for Period 1 resulting from our analysis and presents a reduced set of variables found to have jointly significant coefficients in the model.

With respect to the structural effects for Period 1, the negative and significant coefficient on *alternating k-star* suggested that PIRA’s network is *not* dominated by a few nodes with high degree, where a “high degree” node is

**TABLE 2** MCMCMLE of IRA Network (Period 1)

	Parameters	Est.	S.E.	<i>t</i> value
<b>Structural Configuration</b>	Alternating K-stars	-0.2320	0.1131	-2.05**
	Altering K-triangles			
<b>Demographic Information</b>	Gender (Female =1)	0.6220	0.2602	2.39**
	Same Gender (Female =1)	0.6944	0.3003	2.31**
	University	0.5858	0.3841	1.53
	Same University	0.4641	0.4076	1.14
	Marital Status (Married =1)	0.1768	0.1137	1.55
	Same Marital Status	0.5020	0.1046	4.80***
	Recruiting Age	0.0101	0.0074	1.36
<b>Brigade Membership</b>	Recruiting Age Similarity	1.7434	0.7150	2.44**
	Antrim Brigade	-0.4086	0.0900	-4.54***
	Same Antrim Brigade	1.2042	0.134	8.99***
	Derry Brigade	-0.5991	0.3161	-1.90*
	Same Derry Brigade	0.2491	0.3392	0.73
	Armagh Brigade	-0.2533	0.2693	-0.94
	Same Armagh Brigade	0.5928	0.3099	1.91*
	Down Brigade	-2.2266	0.5802	-3.84***
	Same Down Brigade	-1.4658	0.5384	-2.72***
	Tyrone Brigade	-0.2976	0.2324	-1.28
	Same Tyrone Brigade	0.3964	0.2685	1.48
	Fermanagh Brigade			
	Same Fermanagh Brigade			
	<b>NonViolent/Violent Characteristics</b>	Violent	0.3266	0.3665
Same violent		0.7537	0.1679	4.49***
Non-violent		0.1391	0.3423	0.41
Same non-violent		-0.0474	0.3524	-0.13
Violent in Foreign Operation				
Same violent in Foreign Operation		0.9023	0.4072	2.22**
<b>Roles/Tasks</b>	Senior Leaders	1.4162	0.2453	5.77***
	Same Senior Leaders	0.2196	0.2568	0.86
	Gunman	0.2543	0.3790	0.67
	Same Gunman	0.8855	0.2196	4.03***
	IED Constructor	0.4347	0.4030	1.08
	Same IED Constructor	0.8577	0.2883	2.98***
	IED Planter	0.0029	0.3633	0.01
	Same IED Planter	0.5285	0.1721	3.07***
	Foreign Operation			
	Same Foreign Operations	0.0810	0.3524	0.23
	Involvement in bank robbery/kidnapping/hijacking/drugs	0.5863	0.3386	1.73*
	Same Involvement in bank robbery/kidnapping/hijacking/drugs	1.8042	0.3816	4.73***

MCMCMLE = Markov Chain Monte Carlo maximum likelihood estimation.

\* $p < .1$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

one with many connections relative to most other members. Instead, “nodes tend *not* to be hubs [and there is] smaller variance between the degrees” (Robins et al. 2007:198) for this Period. This finding suggests that there is more than one core (for example, multiple clusters) within the network during this emerging Period. Our findings regarding brigades and roles/tasks help define what clusters tended to form.

We also examined how characteristics of the members and their brigade affiliation affect propensity to make connections. The variables included in this analysis are: (1) demographic information about the individuals, (2) their brigade membership, (3) whether the member engaged in violent activities, and (4) roles/tasks the member undertook. In particular, we expected to find PIRA members would generally operate in homophilous networks—that is, they would preferentially create connections to people who are demographically similar—similar in brigade membership, similar in their propensity for violence, and/or similar in role/task.

The stochastic analysis of Period 1 suggests that this network is strongly homophilous in several dimensions. Starting with demographic characteristics, two were significant: gender (5% level of significance) and marital status (1% level of significance). Our gender variable is “1” if the member is female. That is, there is a tendency for PIRA members to sort by gender (female vs. male) and by marital status (married vs. unmarried status). Also, the coefficients on “gender” and “age at recruitment” are significant at the 5% and 10% levels, respectively. These findings imply that (1) female members and (2) members who were older at recruitment tend to have more connections, on average, than male members or younger members.

Second, brigade membership tended to structure network connections. The coefficients on “Same Antrim brigade” and “Same Armagh brigade” are positive and significant at the 1% and 5% levels, respectively. These imply a higher tendency for members in both Antrim and Armagh brigades to make ties within their brigade than with members of other brigades. In particular, given the negative and significant coefficient on “Antrim brigade” (1% level of significance) and relatively large magnitude of coefficient on the “Same Antrim brigade” (coefficient = 1.2032), a member who belongs to the Antrim brigade seems to be particularly likely to make connections only within Antrim, whereas members of other brigades are somewhat more likely to connect between brigades. By contrast, the Down brigade seems to be poorly integrated. The negative and significant coefficient on “Same Down brigade” at the 1% significance level suggests that Down brigade members have a propensity to create ties with members of other brigades, which leads to a heterogeneous Down brigade network.

Third, our results suggest that members’ engagement in violence influences the formation of clusters or tightly interconnected groups within this network. The coefficients on “Same violent” and “Same violent in foreign operation” are positive and significant at the 1% and 5% levels, respectively.

Members who engage in violence tend to have relationships with other violent members in both operational areas.

Fourth, we expected that individual roles/tasks help to explain the networking patterns between PIRA members. Four roles/tasks-based homophiles were found within this network (all coefficients are positive and significant at 1% level of significance): (1) IED constructors, (2) IED planters, (3) gunmen, and (4) members who have committed crimes (bank robbery, kidnapping, hijacking or drugs). Members engaged in these activities all tended to cluster together.

## Period 2

Table 3 reports Period 2's model with a reduced set of variables, which were tested to be jointly significant.

For Period 2, our results do not show any statistically significant structural configurations. However, the sign of coefficient on *alternating k-stars* has changed from negative during Period 1 to positive during Period 2, despite its statistical insignificance ( $t = 0.48$ ). This structural change may imply the emergence of a hub within the network—that is, one or a few highly connected individuals who help to create linkages across the entire network. This would suggest—but not strongly—that the Period 2 network was more centralized than period one's network.

Again we focus on four dimensions: (1) demographic information, (2) brigade memberships, (3) engagement in violence, and (4) roles/tasks. First, as shown in Table 3, the coefficients on “Same marital status” and “Recruiting age similarity” are significant at the 1% level. Both are strong predictors of tie formations over Period 2. That is, married PIRA members have a strong preference for making more connections with other married activists than with unmarried ones (see the coefficient on “Same marital status”). Also, members seek others who have been recruited at similar ages to develop their PIRA networking behaviors (see the coefficient on “Recruiting age similarity”). This finding suggests that cohorts developed in the movement: connections are more likely between members recruited at the same time and less likely between cohorts recruited at different times. This has important implications for the flow of information and expertise within the movement, as it suggests some in-built biases against creating inter-cohort links that would facilitate transfer of knowledge from relatively experienced members to relatively inexperienced members.

Second, we found that three brigades were more strongly integrated than others. The coefficients on “Same Antrim brigade,” “Same Derry brigade,” and “Same Armagh brigade,” which are all positive and significant at the 1% level, suggest a preference for connections within brigade and thus a greater degree of clustering and closure in these brigades. Given the positive and significant coefficients on “Derry brigade” and “Armagh brigade,”

**TABLE 3** MCMCMLE of IRA Network (Period 2)

	Parameters	Est.	S.E.	<i>t</i> value
<b>Structural Configuration</b>	Alternating K-stars	0.0481	0.1075	0.45
	Altering K-triangles			
<b>Demographic Information</b>	Gender (Female =1)	0.6427	0.3067	2.10**
	Same Gender (Female =1)	0.4811	0.3500	1.37
	University	-0.1833	0.5110	-0.36
	Same University	-0.1668	0.5275	-0.32
	Marital Status (Married =1)	0.0619	0.1291	0.48
	Same Marital Status	0.5166	0.1142	4.52***
	Recruiting Age	0.0288	0.0064	4.50***
<b>Brigade Membership</b>	Recruiting Age Similarity	2.5332	0.5934	4.27***
	Antrim Brigade	-0.0782	0.0913	-0.86
	Same Antrim Brigade	0.6271	0.1359	4.61***
	Derry Brigade	0.4627	0.1082	4.28***
	Same Derry Brigade	1.0333	0.1746	5.92***
	Armagh Brigade	0.6033	0.163	3.70***
	Same Armagh Brigade	1.2031	0.2567	4.69***
	Down Brigade	-1.6762	0.4815	-3.48***
	Same Down Brigade	-1.3737	0.4272	-3.22***
	Tyrone Brigade			
	Same Tyrone Brigade			
	Fermanagh Brigade			
	Same Fermanagh Brigade			
<b>NonViolent/Violent Characteristics</b>	Violent	0.5093	0.1933	2.63***
	Same violent	0.6905	0.1557	4.43***
	Non-violent	0.0394	0.2989	0.13
	Same non-violent	0.0984	0.2994	0.33
	Violent in Foreign Operation			
	Same violent in Foreign Operation	0.1328	0.3836	0.35
<b>Roles/Tasks</b>	Senior Leaders			
	Same Senior Leaders			
	Gunman	-0.0584	0.1948	-0.30
	Same Gunman	0.2809	0.1667	1.69*
	IED Constructor			
	Same IED Constructor			
	IED Planter	0.1999	0.1874	1.07
	Same IED Planter	0.5405	0.1645	3.29***
	Foreign Operation			
	Same Foreign Operations	1.3851	0.3576	3.87***
	Involvement in bank robbery/kidnapping/hijacking/drugs	0.5314	0.287	1.85*
	Same Involvement in bank robbery/kidnapping/hijacking/drugs	0.6801	0.3016	2.25**

MCMCMLE = Markov Chain Monte Carlo maximum likelihood estimation.

\* $p < 0.1$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

these two brigades may be particularly integrated. Members in Derry and Armagh made more connections on average than members of other brigades and also tended to make those connections within the brigade. Consistent with our Period 1 finding, Down brigade members were still more likely to make heterogeneous ties, expressing a preference for connections with members from other brigades in Period 2.

Third, violent members tend to make more connections with other violent members during Period 2 (see the coefficient on “Same Violent,”  $t = 4.46$ ). Also, since violent members are more likely to create ties with others than those who are not violent (see the coefficient on “Violent,”  $t = 2.65$ ), the Period 2 network has a strong tendency to build interconnected groups between violent members. As in Period 1, there is a general tendency for members to sort into violent and nonviolent subgroups.

Fourth, our results indicate that as in Period 1, there is a tendency for PIRA members to sort by roles/tasks, such as “gunman,” “IED planter,” “Foreign Operations,” and “Involvement in bank robbery, kidnapping, hijacking, and drugs.” The coefficients on “Same gunman” and “Same IED planter” are positive and significant at 10% and 1% levels, respectively. Likewise, the coefficients on “Same Foreign Operations” and “Same involvement in bank robbery, kidnapping, hijacking, and drugs” are positive and significant at 1% and 5% levels, respectively.

### Period 3

Table 4 presents the final model for Period 3 (1981–1989) with a reduced set of variables that were found to have significant coefficients. Since the network for Period 3 has the largest number of members of all Periods, it shows more active and interesting dynamics of members’ networking behaviors than any other observed Period network.

Regarding structural features of this network, the coefficient on *alternating k-stars* is positive and significant at 1% significance level. Period 3’s network tends to exhibit a high proportion of higher order stars. This structure, together with the negative density parameter, represents “connections between a larger number of low degree nodes and a smaller number of higher degree nodes, akin to a core-periphery structure” (Robins, Snijders, et al. 2007:198). That is, there is a higher degree of centralization in this network than in Periods 1 and 2. Nevertheless, our brigade findings also suggest a strong tendency to relate within brigades, which further suggests a control structure: a small core group of leaders that connected and coordinated the brigades.

Turning now to the same set of four variables we examined for Periods 1 and 2, Period 3 demonstrates some of the same connection by homophily found before. As in Periods 1 and 2, the coefficients on “Same Gender” and “Same Marital Status” are positive and significant at the 1% level. The PIRA networks are structured by gender and marital status.

**TABLE 4** MCMCMLE of IRA Network (Period 3)

	Parameters	Est.	S.E.	<i>t</i> value
<b>Structural Configuration</b>	Alternating K-stars	0.5866	0.0632	9.28***
	Altering K-triangles			
<b>Demographic Information</b>	Gender (Female =1)	0.4672	0.1451	3.22***
	Same Gender (Female =1)	0.4912	0.1807	2.72***
	University	0.2763	0.1795	1.54
	Same University	0.2294	0.2067	1.11
	Marital Status (Married =1)	0.1668	0.0563	2.96***
	Same Marital Status	0.2065	0.0613	3.37***
	Recruiting Age	-0.0002	0.0037	-0.05
	Recruiting Age Similarity	-0.0008	0.2908	0.00
<b>Brigade Membership</b>	Antrim Brigade	0.1363	0.042	3.25***
	Same Antrim Brigade	0.8981	0.0807	11.13***
	Derry Brigade	0.3463	0.0552	6.27***
	Same Derry Brigade	0.9362	0.1125	8.32***
	Armagh Brigade	0.3537	0.1205	2.94***
	Same Armagh Brigade	0.6307	0.1726	3.65***
	Down Brigade	-2.7699	0.2754	-10.06***
	Same Down Brigade	-2.655	0.2464	-10.78***
	Tyrone Brigade	0.6908	0.0814	8.49***
	Same Tyrone Brigade	1.0811	0.1425	7.59***
	Fermanagh Brigade			
	Same Fermanagh Brigade			
	<b>NonViolent/Violent Characteristics</b>	Violent	0.2628	0.0884
Same violent		0.2512	0.0799	3.14***
Non-violent				
Same non-violent				
Violent in Foreign Operation				
Same violent in Foreign Operation				
<b>Roles/Tasks</b>	Senior Leaders			
	Same Senior Leaders			
	Gunman	-0.0589	0.0901	-0.65
	Same Gunman	0.3845	0.0909	4.23***
	IED Constructor			
	Same IED Constructor	0.3891	0.1368	2.84***
	IED Planter	0.049	0.0937	0.52
	Same IED Planter	0.3165	0.0967	3.27***
	Foreign Operation			
	Same Foreign Operations	0.4583	0.0958	4.78***
	Involvement in bank robbery/kidnapping/hijacking/drugs	0.5716	0.0938	6.09***
	Same Involvement in bank robbery/kidnapping/hijacking/drugs	0.7368	0.1354	5.44***

MCMCMLE = Markov Chain Monte Carlo maximum likelihood estimation.

\* $p < .1$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

Second, during Period 3, three brigades—Antrim, Derry, and Armagh brigade—tend to develop strong membership-based cliques. As shown in Table 4, the coefficients on “Same Antrim brigade,” “Same Derry brigade,” and “Same Armagh brigade” are all positive and statistically significant at the 1% level. At the same time, the coefficients on “Antrim brigade,” “Derry brigade,” and “Armagh brigade” are also all positive and significant at the 1% level. However, the negative and significant coefficients on “Down brigade” and “Same Down brigade” confirm that there is a high likelihood for the Down brigade not to form ties with those who have the same brigade memberships within the PIRA network.

Once again the network demonstrated a tendency to segment by use of violence. Violent members tended to have more connections, and those connections tended to be to other violent members (see the coefficients on “Violent” and “Same violent” at 5% and 1% levels, respectively).

Fourth, we also found a strong tendency toward homophily by roles/tasks within the network. The coefficients on “Same Gunman,” “Same IED Planter,” “Same Foreign Operations,” and “Same Involvement in bank robbery, kidnapping, hijacking, and drugs” are all positive and significant at 1% levels.

#### Period 4

Table 5 reports the final model for Period 4 (1990–1998), which includes a set of predictors for this PIRA network.

During Period 4 the highly centralized structure built in Period 3 was largely dismantled, as evidenced by the positive and insignificant coefficient on *alternating k-star* ( $t = 0.27$ ).

Also, we found the relative withering of homophily as a motive force behind relational choices as compared to the first three Periods. First, PIRA’s network for Period 4 is homophilous only with respect to three demographic attributes: education (see the positive and significant coefficient on “Same university” at 5% level,  $t = 2.56$ ), age at recruiting (see the positive and significant coefficient on “Recruiting age similarity” at the 5% level,  $t = 2.38$ ), and marital status (see the positive and significant coefficients on “Same marital status” at 1% level,  $t = 5.33$ ).

Second, compared to the strong brigade-based structural features in Period 3, only the Antrim brigade has a high tendency to create new ties with one another based on the homophily of brigade membership (see the positive and significant coefficients on “Same Antrim brigade” at 1% level,  $t = 6.11$ ).

Third, violence is no longer the factor that helps to explain denser patterns of connection. Instead, nonviolence is a better predictor of connection. The coefficients on “Nonviolent” and “Same nonviolent” are all positive and significant at the 1% level. The nonviolent members tend to have

**TABLE 5** MCMCMLE of IRA Network (Period 4)

	Parameters	Est.	S.E.	<i>t</i> value
<b>Structural Configuration</b>	Alternating K-stars	0.0285	0.0926	0.31
	Altering K-triangles			
<b>Demographic Information</b>	Gender (Female =1)	0.0797	0.3655	0.22
	Same Gender (Female =1)	0.1606	0.3941	0.41
	University	0.3023	0.187	1.62
	Same University	0.5584	0.2272	2.46**
	Marital Status (Married =1)	0.1138	0.1158	0.98
	Same Marital Status	0.4941	0.0934	5.29***
	Recruiting Age	0.0043	0.0051	0.84
	Recruiting Age Similarity	1.1381	0.4777	2.38**
<b>Brigade Membership</b>	Antrim Brigade	0.0237	0.0803	0.30
	Same Antrim Brigade	0.7106	0.1134	6.27***
	Derry Brigade	0.1057	0.2062	0.51
	Same Derry Brigade	0.0529	0.2192	0.24
	Armagh Brigade	-0.0988	0.1856	-0.53
	Same Armagh Brigade	0.1205	0.2053	0.59
	Down Brigade			
	Same Down Brigade			
	Tyrone Brigade	0.0303	0.214	0.14
	Same Tyrone Brigade	0.0801	0.2242	0.36
	Fermanagh Brigade			
	Same Fermanagh Brigade			
	<b>NonViolent / Violent Characteristics</b>	Violent	0.1474	0.1619
Same violent		0.2177	0.107	2.03**
Non-violent		0.4846	0.1302	3.72***
Same non-violent		0.7401	0.1469	5.04***
Violent in Foreign Operation		-0.1732	0.1759	-0.98
Same violent in Foreign Operation		0.1762	0.2016	0.87
<b>Roles/Tasks</b>	Senior Leaders			
	Same Senior Leaders			
	Gunman	0.0848	0.155	0.55
	Same Gunman	0.5653	0.1263	4.48***
	IED Constructor	0.3274	0.2376	1.38
	Same IED Constructor	0.5012	0.2424	2.07**
	IED Planter	-0.0162	0.1591	-0.10
	Same IED Planter	0.1369	0.1205	1.14
	Foreign Operation	0.5375	0.1398	3.84***
	Same Foreign Operations	0.8517	0.1625	5.24***
	Involvement in bank robbery/kidnapping/hijacking/drugs	0.1588	0.1588	1.00
	Same Involvement in bank robbery/kidnapping/hijacking/drugs	0.5097	0.1874	2.72***

MCMCMLE = Markov Chain Monte Carlo maximum likelihood estimation.

\* $p < .1$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

relationships with one another during Period 4. The tendency for violent members to network with one another diminished.

However, roles/tasks still help to explain relationships in the network: (1) gunmen (positive and significant at 1% level), (2) IED constructors (positive and significant at 5% level), (3) members who work for the foreign operation (see the positive and significant coefficients on “Foreign operation” and “Same foreign operation” at 1% level), and (4) members who have committed crimes (bank robbery, kidnapping, hijacking, or drugs) all are more likely to connect with others having the same roles/tasks.

## DISCUSSION

Our modeling suggests that there are some important points of continuity in relational structure within PIRA, even as the organization was shaped by the leadership over time and evolved through membership turnover. Period 4 is quite different—and understandably so, given the transformative negotiations that were transpiring during this time. We found four broad drivers of relational structure. First, homophily was less important as a structuring device than was anticipated, with the very notable exception of homophily by brigade (Hypothesis 5). The brigade structure was an important clustering feature throughout, though members were more likely to connect within *some* brigades than others. The clustering tendency was strongest in the Antrim brigade. The Armagh brigade also possessed a strong cluster feature, but only through the first three periods. Interestingly, the Down brigade over the first three periods played an opposite role: its members tended to be less connected and also tended to make connections beyond the brigade, suggesting a less cohesive structure than found in other brigades, but especially in Antrim and Armagh.

The other forms of homophily were only weakly supported. Periods 1 and 3 showed some gender sorting, and the coefficient on gender was always positive. Thus Hypothesis 1 is weakly supported. Age similarity (Hypothesis 2) was only significant in the third period, so it is not supported. Similarly, university attendance was only significant in the fourth period, so Hypothesis 3 is not supported. Finally, recruiting age similarity fluctuates. It is not significant in Period 1, which is not surprising given the movement was just getting under way: there was insufficient time for a cohort effect to take hold. Thereafter, recruiting age similarity (Hypothesis 4) was positive in Periods 2 and 4 and *negative* in Period 3. The Period 3 result suggests efforts were made either centrally or individually through a broad cultural shift to integrate old members with new recruits. Our results suggest a more nuanced consideration of cohort effects—one that must consider whether there are efforts from central leadership to steer the organization in a more integrated direction.

Our modeling unearthed one unanticipated source of homophily: marital status. In all four periods, similarity of marital status was positive and significant. Given that we have controlled for age at recruitment and for participation in violence, marital status is *not* a proxy for either. One could assume that married people are somewhat older (and thus confounded with age) and married people may avoid violence due to family commitments (and thus confounded with willingness to engage in violence). Instead, marital status may be preference for a certain level of maturity—or lack of recklessness—among ones' peers in the movement. So the two most consistent homophilous tendencies are through brigade and marital status, with gender a weaker force.

With respect to behavioral similarity, the results found strong differentiation between the violent and nonviolent members. Per Hypothesis 5, the violent members of PIRA tended to be connected to one another, and in two of the four periods the violent members tended to have more connections overall. The nonviolent members were not particularly likely to connect, contrary to Hypothesis 7—until Period 4, when the groundwork for a negotiated settlement was being put in place.

Regarding violent operations outside Ireland, in Period 1 participation therein provided a basis for connection (per Hypothesis 8) but that was not true in other periods. Our findings regarding Hypothesis 7 and 8 again speak to the need to understand the evolving nature of the Northern Ireland conflict and how that was reflected in the PIRA relational structures that manifested. Turning to roles and tasks, there is very strong evidence that role and task assignment explains relational structure. In fact, the effect was even stronger than we expected. Hypotheses 9, 10, and 11 are largely supported (see Table 6).

Hypothesis 11 is completely supported, with those engaged in kidnapping, robbery, hijacking, and/or drug smuggling being much more likely to share a connection with peers engaged in the same activity. The same is largely true of the IED planters and constructors. IED planters have a strong tendency to connect in three periods and weaker but still positive tendency in Period 4. IED constructors are strongly connected in three of the four periods; the lack of a finding for Period 2 may be the results of missing data.

**TABLE 6** Roles and Task—Patterns of Statistical Significance

	Period 1	Period 2	Period 3	Period 4
Gunmen	X	X	X	X
IED constructors	X		X	X
IED planters	X	X	X	*
Foreign operations	*	X	X	X
Kidnapping, robbery, etc.	X	X	X	X

X = statistically significant.

\*Positive coefficient but not statistically significant.

To dwell on the IED findings for a moment, the results suggest a relatively closed, cellular structure that separated constructors from planters. Our stochastic analysis found no particular tendency for planters and constructors to connect, but our visualizations find what one would expect among clandestine cells: relative closure with a few bridges that were necessary to coordinate activities between the constructors and planters.

Hypothesis 12 was not supported: gunmen were *also* much more likely to connect with one another.

Finally, our expectations about general tendencies toward clustering (Hypothesis 13) were not supported. While Period 3 demonstrated clustering, Periods 1, 2, and 4 did not. Rather than generalized clustering, there appears to be much more important brigade and task-based clustering. Network closure—needed to ensure that a friend of a friend is a friend—was achieved through brigade structure and roles/tasks.

## CONCLUSION

Taken together, our results suggest that PIRA's relational structure over time was consistently influenced by three primary factors: brigade membership, engagement/nonengagement in violence, and task/role. In fact, one might think of an exploration of this structure as a three-step decision tree: (1) Which brigade does a person belong to? (2) Do they engage in violence? (3) If they engage in violence, what was their task or role? Layered over this decision tree are a few other homophilous influences: a strong preference for marital status sorting, a weaker but probably significant tendency for gender sorting, and sorting by recruitment cohorts that may have been interrupted by senior leadership decisions regarding PIRA's general structure. The network data suggests that PIRA leadership interventions to reorganize and restructure the movement "worked" in that structures shifted over time in ways that accord with the known organizational intention of that leadership. In the end our analysis suggests a relatively hierarchical structure with a clear division of labor—as any "traditional" business or nonprofit would generally have.

It is important to note a caveat about our findings: though it was not our intention to do so, our results are not generalizable to all terrorists or IED networks. Our results found some effects that are so prevalent or strong that they could not have been generated by random chance *in these networks*. The results are thus generalizable to current and potentially future states of *these networks* but not necessarily other terrorist networks. However we believe these results are indicative of what we might find in other terrorist networks and may provide an important, generalized blueprint for how terrorists construct cells for IED operations within the context of a large, well-structured organization. A deeper examination of these dynamics may also carry significant operational implications for

counterterrorism agencies that seek to embed individual informants within a wider network of members.

Perhaps, the finding that common brigade membership predicts connection is not surprising considering that brigade membership was geographically assigned and located within Northern Ireland. This leaves us with the question of whether the fact that Brigade membership matters is a result of opportunity or proximity. While this question remains unanswered, future studies using this data may make use of GIS software to measure the distance between the nodes' home addresses. Recent studies have utilized GIS to show the spatio-temporal clustering of terrorist attacks (LaFree et al 2012; Johnson and Braithwaite 2009; Braithwaite and Johnson 2012) and the distance-to-crime correlates of IED attacks (Gill and Horgan 2012) and suicide bombings (Gill 2012). We believe that such an approach would lead to a more precise and focused understanding into how geography impacts upon network formation.

Finally, this research also serves to illuminate what is capable from open-source data collection endeavors. The extent and depth of the network coupled with the layering of attributional data represents, in our view, a major step forward for the social network analysis of terrorist networks. While replication studies of other terrorist organizations may prove to be more cumbersome due to language barriers or access to relevant open-source reporting, we believe that comparative studies that replicate our methodology are important and realizable particularly for Western-based networks.

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