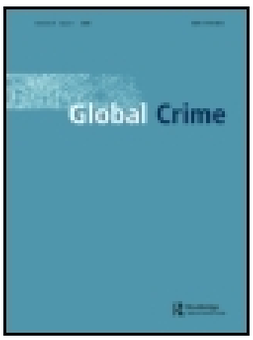

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Brokering between (not so) overt and (not so) covert networks in conflict zones

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ABSTRACT

There is a tendency to consider covert networks as separate from overt networks. Drawing on data from the Democratic Republic of the Congo, we demonstrate that this is not the case and identify how covert and overt networks are mutually constitutive. While most studies of African brokers have relied on network metaphors like 'Big Men' and 'social membranes', we consider the embeddedness of 'covert' networks in 'overt' networks explicitly. We perform two analyses on a large original dataset encompassing 396 partially overlapping ego-nets obtained from a hybrid link-tracing design. An ego-net analysis reveals a large degree of homophily and a deep embeddedness of the different networks. A multilevel exponential random graph model fitted to the reconstructed network of a 110-node subset shows that demobilised combatants are the actors likely to broker between armed groups, state forces, and civilian blocs, suggesting their capacity to broker peace or foment war.

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DRC; covert networks; brokerage; armed groups; network sampling; network imputation; ERGM

Introduction

People living in conflict-affected states are often faced with constantly changing territorial and political control as it is challenged and negotiated between representatives of 'the state', armed groups, and a host of other actors and organisations. Despite this volatility, they somehow survive. This paper investigates the socio-economic connections that facilitate their survival in however dire circumstances. It aims to identify the individuals who broker between contesting state and non-state groups and organisations; whose activities hover on a spectrum between licit and illicit, legal and illegal, official and non-official, covert and overt. Their interventions often determine whether conflict escalates to war or diffuses to tentative peace.

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Interventions in the form of 'disruption' have received a lot of attention in the literature on covert networks.[1] While some recognise the limits of identifying points of disruption through centrality measures,[2] the majority of research limits the notion of disruption to identifying central actors. More consequentially and with very few exceptions,[3] covert networks are considered in isolation and the effectiveness of disruption is not contingent on how the covert network is embedded in overt networks.

The literature stipulates that where formal state institutions are dysfunctional or predatory, informal social support networks, already crucial to social cohesion, become ever more important in securing livelihoods and protection.[4] Yet, in eastern Democratic Republic of the Congo (henceforth the Congo),[5] such personal support networks may involve state actors, such as military officers, acting according to non-official logics and sometimes engaging in illegal activities.[6] As a result, the state/non-state divide does not correspond to the formal/informal dichotomy. In addition, illegal activities perceived as providing socio-economic, political, or physical security are often considered 'licit'.[7] This also applies to the activities of non-state armed groups, which are closely interwoven with local populations – many people have a brother, cousin, uncle, former classmate or colleague, co-villager or co-religionist serving in an armed group.[8] Hence, the networks under consideration herein – which following Callaghy we term 'brokerage networks'[9] – are not easily classified in dichotomous terms (illicit, informal, criminal).[10] Moreover, they do not discriminate between nodes that are civilians, state representatives, or warlords. Our research questions are: how can we characterise different actors' access to different resources (like jobs, information, and emotional support) and thereby identify the mechanisms whereby actors bridge different layers of society?

To analyse how brokerage networks are configured and structure socio-economic life, we draw on primary data from the Congo. The key units of analysis for the study were 396 respondents recruited using a hybrid link-tracing design. Participant-aided sociograms[11] were used both as a tool to recruit subsequent respondents and to ascertain social ties between respondents' alters and those alters' characteristics. We interrogate our research questions in two parts. A first analysis defines multilevel measures of tie- and alter-dispersion and egocentric network (ego-net) homophily by respondent category for all ego-nets. The second analysis performs a complete network analysis on a subset of nodes for which (some) alter-alter ties are available, allowing us to statistically test network mechanisms while simultaneously controlling for competing factors. The multilevel exponential random graph model[12] of the second part relies on a Bayesian data-augmentation scheme to account for the sampling design.

The paper is structured as follows: we first set the scene with a brief historical background of violent conflict in the Congo to contextualise the study; we then provide an account of the study design and data collection approach. Following basic descriptives of the dataset, we subsequently investigate the different measures of group-category positions based on the ego-nets. After identifying some limitations associated with analyses of brokerage for sampled networks, we present a framework for analysing partially observed networks and apply it to a subset of the data. We conclude by discussing our results and their implications for understanding dynamics of conflict in the region and the characteristics of brokers positioned to mediate or exacerbate violence.

Historical background

War and armed conflict have marked the Congo throughout its tumultuous history. In recent decades, the most notorious episodes of armed conflict include the First (1996–1997) and Second (1998–2003) Congo Wars. These wars followed in the wake of the 1994 Rwandan Genocide, which claimed the lives of nearly a million people and rendered another million refugees in the Congo[13] (then called Zaïre). These predominantly Hutu refugees' militarisation and subsequent attacks on Rwanda and Congolese citizens prompted the Rwandan Patriotic Front (RPF), the politico-military movement that constituted the Rwandan government, to invade Zaïre in 1996, setting in motion events culminating in two regional wars. The Second Congo War embroiled nine African countries and dozens of Congolese and foreign armed groups. While a peace agreement adopted in 2003 formally ended the war, fighting has continued in the country's volatile east, where state and non-state armed actors hold sway over different spheres of social life – including politics, the economy, and conflict regulation.

One reason for the protractedness of violent conflict in the east is the complex enmeshing of regional, national, and local conflict dynamics.[14] In addition to regional involvement, and national power struggles, war has been driven by a long history of inter and intra-communal tensions, often related to contestations around territory, local authority, and citizenship that are expressed in (ethnic) identity-based terms.[15] The geographical epicentre of many of these conflicts has been the Kivu provinces bordering Uganda, Rwanda, and Burundi. This study focuses predominantly on North Kivu's Masisi and Rutshuru Territories (sub-provincial divisions).

The Belgian colonial administration (1908–1960) resettled Rwandans (first Tutsi, then Hutu) in Masisi and later Rutshuru from the 1930s through 1956.[16] These immigrants – known as Banyarwanda (a category also including Hutu and Tutsi living on what is now Congolese soil before the colonial era, like the Banyabwisha) – displaced resident Hunde from what they considered to be their ancestral grounds, became the demographic majority, and in some contexts dominated local governance.[17] Violent clashes over land access and political control erupted for the first time just after independence during the so-called *Guerre de Kanyarwanda*.[18] While violence soon subsided, tensions would intensify again in the 1970s and 1980s, as prosperous Banyarwanda acquired colonial-era plantations through changes in property laws, thereby dispossessing poor farmers.[19] By the late 1980s, as a transition towards multi-party democracy loomed on the horizon, political leaders increasingly manipulated ethnicity and conflicts around land and local authority to secure constituencies.[20] Concomitantly, local communities established their own militias for protection; some of these were supported by local self-help organisations organised along ethnic lines and known as *mutuelles*, such as the Banyarwanda-linked MAGRIVI (*Mutuelle des Agriculteurs des Virunga*).[21] Others, in particular groups later known as Mayi-Mayi, linked to the Hunde and Tembo ethnic groups,[22] had their roots in independence-era rebellions as well as precolonial and colonial-era cults and initiation societies.[23] The arrival of over a million Rwandan refugees – including government officials, soldiers, and perpetrators – fleeing the genocide in 1994 and the new RPF regime that took over in its wake reinvigorated these militias on all sides.

Threatened by raids from the militarised refugee camps, the RPF cobbled together a Congolese-regional rebellion, the *Alliance des Forces Démocratiques pour la Libération du Congo-Zaïre* (AFDL). Led by the Rwandan Patriotic Army (RPA), the armed forces of the RPF

regime, the AFDL invaded eastern Zaïre and ousted its president Mobutu Sese Seko in 1997. Discontent with the policies of the new president, Laurent-Désiré Kabila, his erstwhile backers Rwanda and Uganda started a new rebellion in 1998 to remove him from power, the *Rassemblement Congolais pour la Démocratie* (RCD). Similar to the AFDL, Congolese Tutsi and Hutu played an important role in the RCD, seeing it as vehicle to secure political and economic influence in the face of a long history of political exclusion.[24] In the course of the ensuing war, Kabila allied with affiliates and members of the former (Hutu-dominated) government of Rwanda, including the army, which had arrived in 1994 and had since remobilised. These forces formed a politico-military movement that would become known in 2000 as the *Forces Démocratiques de Libération du Rwanda* (FDLR).[25]

The peace accord adopted in 2003 stipulated that all ex-belligerents had to either disband their armed wings or integrate them into the new national army, *Forces Armées de la République Démocratique du Congo* (FARDC). In Masisi and Rutshuru, ex-RCD troops came to formally constitute brigades of the FARDC but refused to redeploy or be mixed with other troops. These brigades became the backbone of a new rebellion in 2006 known as the *Congrès National pour la Défense du Peuple* (CNDP) whose leadership, like that of the RCD, was dominated by Congolese Tutsi. Its formal goals were combatting the Rwandan Hutu-dominated FDLR, repatriating Congolese Tutsi from Rwanda, and overthrowing President Kabila.[26] On 23 March 2009, the CNDP's rebellion formally ended as they had integrated their troops into the FARDC. However, within the FARDC, they maintained parallel chains of command, revenue, and intelligence. This facilitated the desertion of a discontented wing of the ex-CNDP from the FARDC in 2012 and heralded the start of a new rebellion, the M23, named after the 23 March accord it claimed had not been respected. M23's demise coincided with what is locally known as the 2013 'Mudahunga War' or '*Guerre de Kitshanga*' between, on the one hand, FARDC dominated by Rwandophones (as Banyarwanda are now called) and, on the other hand, the Hunde Mayi-Mayi militia *Alliance des Patriotes pour un Congo Libre et Souverain* (APCLS) led by commander Janvier Buingo Karairi.[27] Each of these rebellions were territorially rooted in the areas that are the focus of our study (see Figure 1).

Both Masisi and Rutshuru reflect wider trends in the armed group landscape across eastern Congo, namely a process of fragmentation due to the scattering and splintering of larger politico-military movements and the proliferation of smaller scale armed groups often formed by army deserters.[29] In 2008, a large peace conference that gathered all armed groups active in the Kivus concluded with a cessation of hostilities, which was signed by 23 groups (some of which were even created for the occasion).[30] Between 2015 and 2018, the approximate count of armed groups rose from 70 to over 120 [*sic*].[31] To illustrate the network of positive and negative ties among a subset of these armed groups operating in and around Masisi and Rutshuru, we diagrammed these ties (Figure 2) for a number of groups, based on studies by Bafilemba and Mueller, and Vogel,[32] and in consultation with Mueller and Vogel.[33]

The sociogram in Figure 2 represents a snapshot of a moment in time: the alliances and enmity between these groups as of 2 August 2013. This particular configuration is the product of years of change and realignment, as groups were rebranded and rechristened, merged and split, were integrated into the national army and subsequently broke from it.[34] Since 2013, the kaleidoscope has shifted and reshaped countless times over; the landscape is continuously changing. Now, as then, eastern Congo remains a complex and highly network-dependent context.

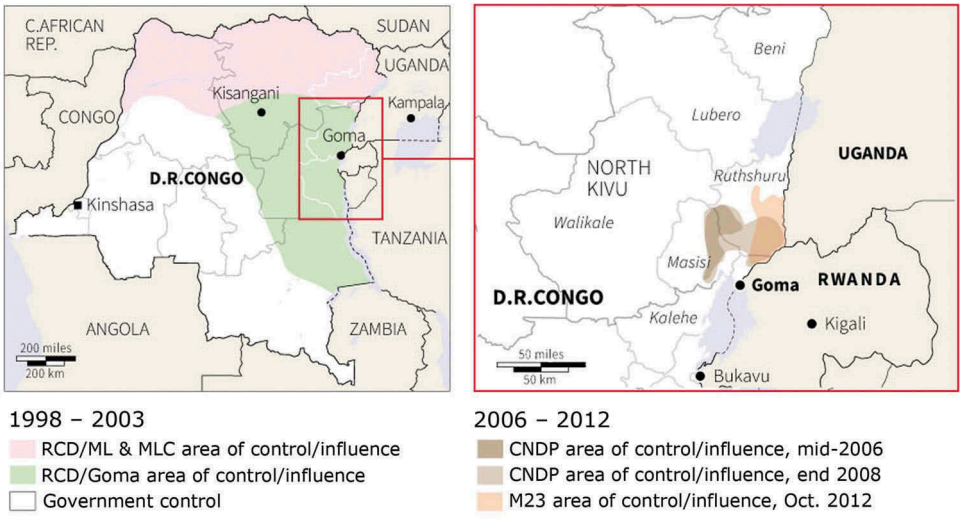

Figure 1. RCD, CNDP, M23 rebellions: Main areas of armed group territorial control/influence.[28]

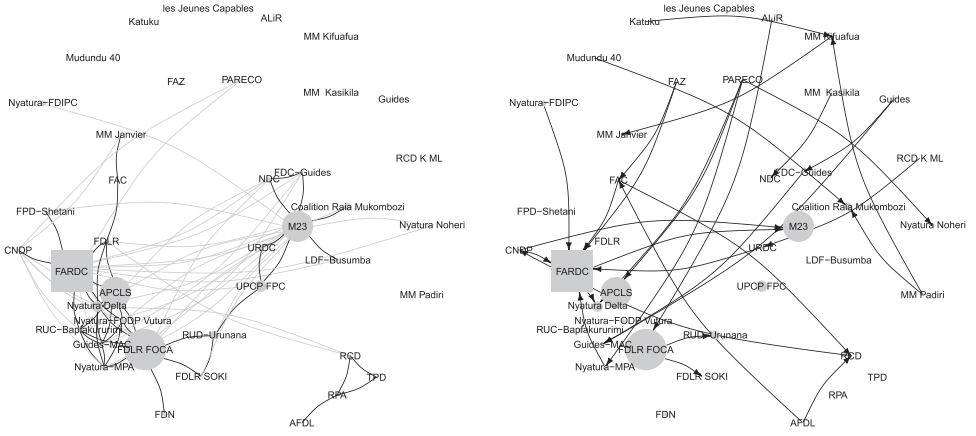

Figure 2. Alliances (black) and enmity (grey) ties (left) and predecessor to successor/splinter (right) between armed groups in and around Rutshuru and Masisi territories as of August 2013. Node size of armed group is proportional to approximate troop numbers (apart from FARDC).

Research design and data collection[35]

Following expert reviews of the methods and instruments and cognitive interviews, a pilot study was undertaken as part of later data collection.[36] 'Participation' in armed groups was disaggregated into being civilian members, militarily trained members, and leaders/founders. Civilians' affiliations ranged from not knowing anyone in armed groups, knowing some members, and supporting armed groups as non-members. Participants were members of covert and hard-to-reach populations and social structure was crucial to our investigation. Thus, starting with a seed set determined in consultation with local experts and based on desired target groups,[37] we grew the sample using

a link-tracing design.[38] Subsequent participants were recruited based on the contacts of previous ones. Not all the nominees were followed up and interviewed (which would have been the case with a snowball sample), but network data was collected on all respondents (which would not have typically been the case with respondent-driven sampling); the sampling method was a hybrid design. A by-product of this design was a partially observed, multilevel network consisting of partially overlapping ego-nets.[39]

Network ties

Personal support networks were delineated using the exchange approach.[40] Based on the theory of social exchange, the approach assumes that 'people who are sources of rewarding interactions will be particularly important in shaping respondents' attitudes and behaviours'.[41] Social support, following Thoits, is defined as 'helpful functions performed for an individual by significant others such as family members, friends, co-workers, relatives, and neighbours'.[42] Specified interactions are instances of social support and thus pre-eminently suitable for delineating personal support networks. Likewise, interactions are very specific and likely to be interpreted in the same way by all respondents. To account for potentially supportive relationships in which no recent supportive interactions occurred, interactions were not temporally bound. The three dimensions of instrumental support, social companionship, and emotional support were operationalized by asking about 'loans' and 'work/jobs', 'visiting/spending recreational time together', and 'advice with a major change in your life, like changing jobs or moving to another area', respectively.

Network ties were elicited through participant-aided sociograms,[43] using whiteboards and markers to diagram ego-nets. Participants drew their personal support networks, discussed ego-alter and alter-alter ties, and grouped their nominations by drawing circles around alters. Alters elicited through the three name generators were not mutually exclusive. The pilot demonstrated that emotional support does not occur without social companionship, which respondents conceptualised using the term 'rafiki proche'[44] ('close friend', drawing on Swahili and French).

Basic descriptives

Egos and alters

Figure 3 provides a representation of the sample and sampling design for a subset of data (a semi-supervised entity resolution scheme has been applied). The network diagram is partial in that the alter-alter ties are not displayed. Nodes clearly cluster around specific organisations, represented by blue squares in the figure. We can symbolically denote the one-mode, person-to-person network by the adjacency matrix $A = (a_{ij})$, $(i, j \in V)$. We can further represent the membership in different armed groups as a person-by-armed group affiliation matrix $B = (bij)$, $(i \in V, j \in G)$. Many armed groups were founded predominantly to protect their communities from other armed groups' attacks, which can be represented by inter-organisational ties. Here, we address ties of a positive nature such as alliances and co-operation and collect these in an organisation-by-organisation adjacency matrix $D = (d_{ij})$ $(i, j \in G)$.

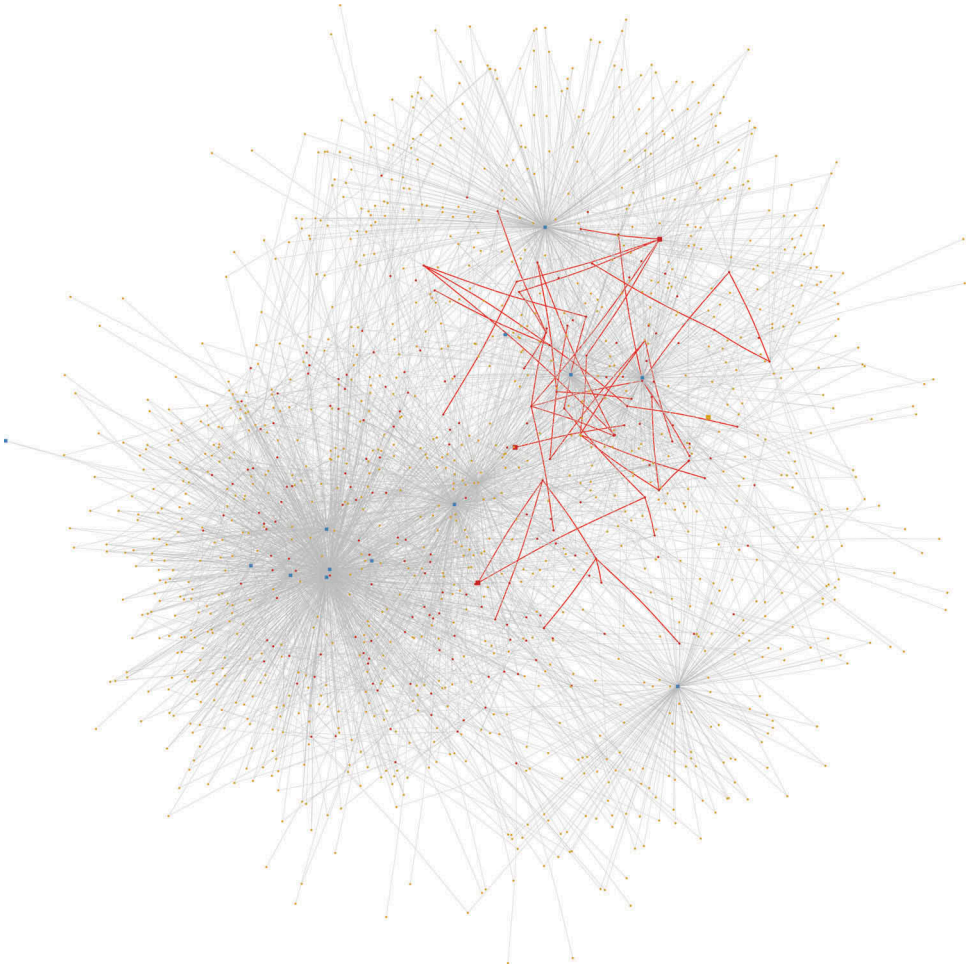

Figure 3. Example of three chains for a subset of the dataset (207 respondents, 1,086 alters, no alter-alter ties). Respondents (red nodes), non-interviewed alters (gold nodes), and key affiliation nodes (blue squares). The sample paths (red) for three seed nodes (red squares) are indicated.

Men comprise about 60 per cent of 396 respondents (egos). Half of these respondents are militarily active (combatants), serving in state security forces and non-state armed groups; about a third are demobilised combatants who now lead civilian lives, including those who auto-demobilised and those who participated in formal demobilisation programmes.[45] The minority are civilians, yet only in this category women outnumber men.

The vast majority are multilingual; we used respondents' first language (mother tongue) as a proxy for their ethnicity (e.g. 'Rwandophone'[46] for those speaking Kinyarwanda, Kinyabwisha, and other dialects; 'Kihunde' for those who speak Kihunde and belong to the Hunde group, etc.). Like nationalism, ethnicity is a form of collective identification and belonging rooted in the invention of shared history, culture, and language,[47] which in the Congo provides opportunities for political and armed mobilisation.[48] As evidenced in the second section, ethnicity in this case was politicised and compounded with socio-economic status and nationality.[49]

Respondents represent seven language groups. The sampled population is overwhelmingly Hunde and Rwandophone, the next largest group being Lingala-speakers (predominantly military from western Congo), who are almost all men. Notably, there are very few Rwandophone civilians. Hunde, in terms of subgroups, have the greatest proportion of militarily active men.

The sample represents 25 past and present armed groups, evoking the complexity of militarised networks illustrated in Figure 2. The vast majority of demobilised combatants were members of multiple armed groups, having undergone cycles of mobilisation, demobilisation, and remobilisation, as well as re-affiliation due to splits, mergers, rebranding, or actually changing membership.

About half of the respondents have been members of the RCD rebellion active during the Second Congo War. CNDP and Mayi-Mayi Janvier (current APCLS leader Janvier's group before forming the APCLS) were the next most popular groups in terms of membership, followed by APCLS. Demobilised combatants who had participated in the AFDL (the rebellion that kickstarted the First Congo War in 1996), RCD (1998–2003), CNDP (its successor, 2004/5–2009), and the RPA (the armed wing of the RPF rebellion and then regime) are predominantly Rwandophone. Similarly, membership of Mayi-Mayi Janvier, APCLS, Mayi-Mayi Kifuafua, and PARECO (umbrella militia group into which Janvier integrated in 2007 and from which his APCLS split) was mainly Hunde. Overwhelmingly, and referring to the historical background above, rapport between the groups in which the two communities participated was vitriolic and antagonistic. No armed group, however, was mono-ethnic.

Considering the composition of active armed groups in the area, based on their members' language groups, the conclusions are in line with the narrative of inter-group conflict presented above.[50] Like in the 1960s and 1990s, combatants from the area's two dominant language groups constitute opposing factions. Hunde comprise the vast majority of the APCLS, a non-state armed group, whilst Rwandophones dominate the FARDC and PNC, respectively the national army and police. Prior to integration into these state forces, many were members of RCD and CNDP, against which APCLS (and PARECO and Mayi-Mayi Janvier before it) mobilised. However, there is an opportunity for some Hunde and Rwandophone rank-and-file combatants to fight together in these groups, be it contrary to the dominant tendencies of their respective communities and top leadership.

Civilians, demobilised, and active combatants' income-generating activities are not mutually exclusive. Most respondents pursue various types of work simultaneously or seasonally to secure their livelihoods – even soldiers and police officers. Respondents mentioned 44 different vocations in interviews. Main income-generating activities in the area are, for the most part, pursued by both sexes, Rwandophone and Hunde alike (Figure 4). Whilst soldiering or police work may exacerbate inter-communal tensions (considering the ethno-linguistic composition of dominant armed groups),[51] farming and varied and sporadic short-term work are all forms of employment in which Rwandophones and Hunde may collaborate – civilians and former and current combatants. Militarily active Hunde's occupational portfolios are more diversified than those of Rwandophones. Local alcohol production appears to be dominated by militarily active and demobilised women and the sex trade by the latter. Demobilised men cited prolonged unemployment more often than any other subgroup.

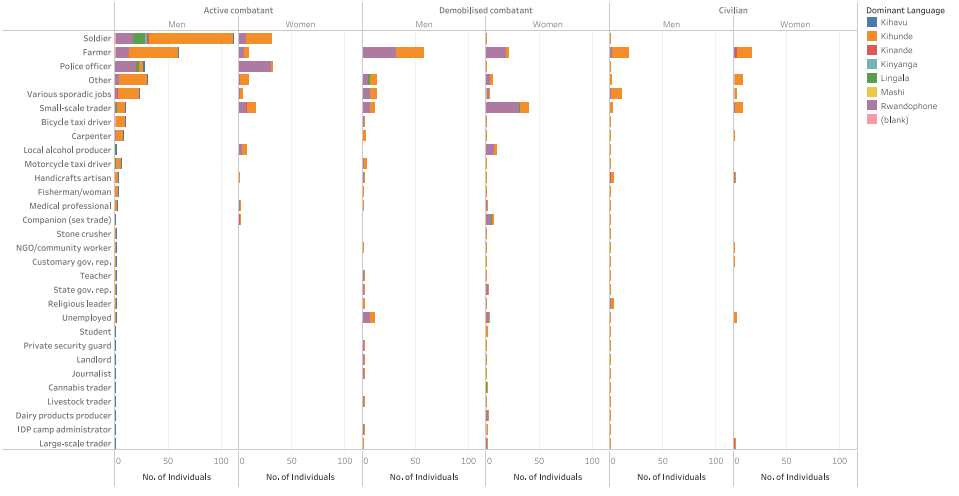

Figure 4. Income-generating activities: Dominant language groups by population subgroup and sex.

Ego-net analysis

In terms of access to, or brokerage between, different armed groups, the descriptions of egos' actor attributes illustrate ethno-linguistic variations between different groups, reflecting eastern Congo's history of inter-group conflict. Additionally, brokerage is likely associated with livelihoods and access to resources. Here we investigate these dynamics through social interactions between respondents and their alters.

Methods

The rich literature on leadership and brokerage roles in covert networks,[52] with few exceptions,[53] identifies central actors by calculating standard network metrics on a network (assumed to be completely observed).[54] Individual actors are then typically investigated to ascertain the reasons for their centrality and the possible network consequences of their position.[55]

From the perspective that network ties are instrumental and reflect organisational capabilities, centrality and reach in covert networks have particular importance for the so-called efficiency/security trade-off.[56] On the one hand, one would expect individuals to minimise the risks associated with creating and maintaining ties but on the other, for operational reasons, communication and collaboration in the covert network needs to be efficient and effective. Some have even argued that the need for co-ordination leads to highly centralised networks with prominent hubs.[57] The claims and proposed reasons for covert networks being centralised or decentralised, dense or sparse, having brokers or not, etc. are contradictory[58] and can often be seen as artefacts of considering the covert network as designed rather than created by individuals.[59]

If the ties of the covert network are considered 'naturally occurring' rather than created by design, the effective capacity of actual covert collaboration ties may be contingent on other, non-covert ties. One could even argue that overt ties increase the resilience of covert ties.[60] Covert networks may exist in separation from overt

networks, but often covert networks are more or less embedded in or entangled with non-covert social networks.[61] Such embeddedness is even a defining feature of some covert networks. For example, the operational success of the Provisional Irish Republican Army was crucially dependent on its embeddedness in civil society and the explicit reliance on social ties involving non-combatants.[62] Similarly, in eastern Congo, most armed groups depend crucially on civilians for intelligence, logistics, recruitment, political communication, and revenue generation.[63] The same applies to state security actors' engagement in illegal revenue generation activities, such as unauthorised fishing and logging, the trade in stolen cars, cannabis or prohibited alcohol, or road robbery and burglary.[64] These activities generally involve a range of state and non-state, armed and non-armed actors that together constitute what might be called a 'criminal network'. 'Overt' actors, such as military officers, often play a crucial role in these networks, for instance by 'protecting' banditry rings, providing them with arms and ensuring they can operate freely.[65] In our study, the reciprocal nature of the embeddedness of covert networks in non-covert networks is the conceptual challenge – the non-covert social support networks cannot be understood or even disentangled from their embeddedness in covert networks, and vice versa.[66]

Consequently, we are not necessarily interested in the centrality of particular individuals. This would conflate the different types of ties to different types of categories of individuals; nodes have not only different formal capacities, but ties are also multiplex.[67] While Burt's metrics[68] for measuring brokerage of focal actors are now standard, these measure a particular form of brokerage that here would conflate the different types of ties and actors. Furthermore, for the purposes of analysing the nominations of the respondents we want to investigate brokerage that is not contingent on the ties between alters.

In terms of investigating brokerage relative to different groups or categories, Gould and Fernandez developed just such a measure.[69] However, their measure only allows for non-overlapping networks. We therefore adopt the notion of multilevel embeddedness[70] whereby we can ascertain to what extent the person-to-person ties in A are contingent on the affiliations of individuals $i \in$ to illicit organisations and non-illicit categories $j \in G$. In Figure 5, the alters of a all belong to the same group as a, hence providing a with no opportunities for brokering between groups. Ego b, on the other

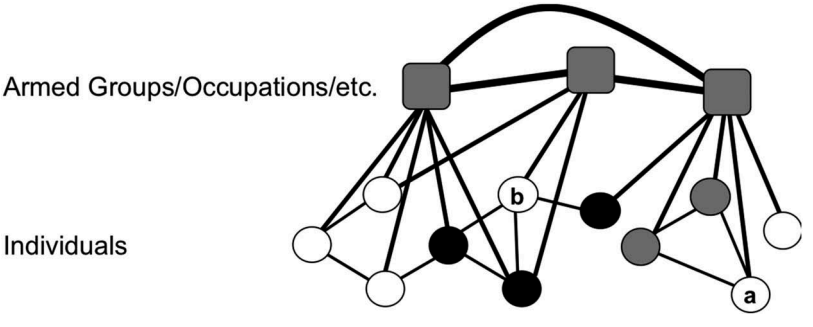

Figure 5. The duality of multilevel brokerage and overlapping alter dispersion. A multilevel network[71] with inter-personal ties A, personal affiliations B, and inter-organisational ties D.

hand, has alters that not only belong to the same group as b but also provide b with access to another two groups.

Everett and Borgatti devised a suite of metrics[72] designed explicitly for overlapping group memberships or categories. The key to defining a measure of multilevel brokerage is to identify the correspondence between representing categories as attributes of nodes, on the one hand, and attributes as affiliations, on the other. While not a novel idea,[73] recent literature[74] demonstrates the added insights that the network two-mode representation of nodal attributes provides. Everett and Borgatti define the overlapping categories of actors in the form of a person-by-category affiliation matrix $B^* = \left(b_{ij}{}^*\right)$.[75] To account for the variation in diversity of individuals, the measures are calculated for the row-normalised affiliation matrix $B = \left(b_{ij}\right)$. Thus, if someone has many affiliations then they would necessarily have less time and energy to devote to each one than an individual with a single or a few affiliations.

For example, we would tacitly assume that an actor who belongs (or has belonged) to FARDC, CNDP, and RCD would have a tie to each of these armed groups with a strength of 1/3. An actor whose military career included only one such affiliation, for example M23, would have a tie to M23 with a strength of 1. While many armed groups in our sample are rebranded or reconstituted forms of precursory groups, we posit that their reconstitution and rebranding entailed differing experiences for their members, in terms of shifting objectives and organisational structures as well as the historical and socio-political contexts in which they were active. Likewise, despite participating in numerous armed groups over time, very few demobilised or active combatants have the same exact history of military membership.

Now, assume that person i is not affiliated to armed group j, in other words $b_{ij} = 0$, but that person i has a friend k, $a_{ik} = 1$, who is affiliated to armed group j, $b_{kj} > 0$. Hence $a_{ik}\ b_{kj} > 0$ and i has indirect access to armed group j through k. The matrix $C = AB$ thus is a person-by-organisation matrix that identifies each individual's access to different organisational categories. Everett and Borgatti create a normalised matrix P whose p_{ij} element is defined as c_{ij}/d_i, where $d_i = \sum_{k=1}^{n} a_{ik}$ is the degree of person i.[76] The element p_{ij} is then the average resource in the alters and can be thought of as the proportion in, for example, Blau's H.

Blau's H measures the dispersion of the different types of ego's alters. For overlapping categories, it is defined as

$$H_i = 1 - \sum_{j=1}^{m} p_{ij}^2,$$

for each ego i.[77] Thus, if ego i has one alter and this alter belongs only to one group j, then $H_i = 0$. If ego i has d_i alters and they all belong only to one group j, then again $H_i = 0$. Actor a in Figure 9, for example, has two alters and both of these belong to the same group and hence $H_a = 0$. Actor b, on the other hand, has three alters that belong to three different groups giving $H_b = 0.61$. In our analysis, we study the diversity of ego-nets of different categories of actors, positing that types of actors that have more diverse ego-nets are those that broker between different groups, armed and otherwise.

Another aspect to brokering between groups is the extent to which an actor connects groups that are different from their own. For example, in Figure 9, the alter of b who has two affiliations is not necessarily contributing to brokerage between groups as this actor is

affiliated with a group to which *b* is already connected; the external tie is redundant given the other alters. To measure the extent to which an individual thus has personal ties that connect the actor to different groups, Everett and Borgatti derive the number of external ties from the number of internal ties defined by *B*.[78] The number of internal ties of *i* is defined as

$$I_i = \sum_{j=1}^{m} b_{ij} \sum_{k=1}^{n} a_{ik} b_{kj},$$

which, in other words, indicates the extent to which the alters of *i* are affiliated with the same organisations as *i*. For I_i affiliations of the same 'strength' as that of *i* are more important. The EI Index for overlapping group memberships is then given by

$$\frac{E_i - I_i}{E_i + I_i} = 1 - \frac{2I_i}{d_i},$$

and ranges between −1 and 1, from perfect homophily (ego only has ties to those like itself) to perfect heterophily (ego only has ties to those different from itself).

Results

Degree

Breakdowns of the degree distributions by categories revealed no apparent differences between egos despite the great overall heterogeneity in the number of alter nominations.[79] Further cross-classifications do not reveal any other substantial differences. Thus, purely in terms of (degree) centrality, there do not appear to be any groups that are better positioned for brokering between other groups.

Homophily

Homophily is one of the most persistent empirical phenomena in social networks. With the history of conflict and ethnic cleavages, there is little reason to assume that homophily would not be an important factor in eastern DRC.

Degree centrality does not elucidate alters' characteristics. Figure 6 provides a first view of how different categories relate to one other, revealing a high degree of homophily. Civilians mostly nominate civilians. Demobilised, technically civilians at present, nominate civilians but also other demobilised combatants. The active combatants that they do nominate are most likely members of the armed groups from which they demobilised (or groups with which these were affiliated; see Figure 2). Egos that are active combatants nominate active combatants from their own armed group but – mirroring the pattern for civilian and demobilised egos – they also nominate civilians and demobilised. The (relative) symmetry of the ego-alter ties lends some validity to the sampling design (for a well-constructed sample, we would expect the egos to balance the alters[80]).

Multilevel brokerage – Blau's H

Figure 7 provides Blau's H (normalised to Agresti's IQV) indices[81] of multilevel brokerage by population subgroup and dominant language group, examining access to diverse armed groups.

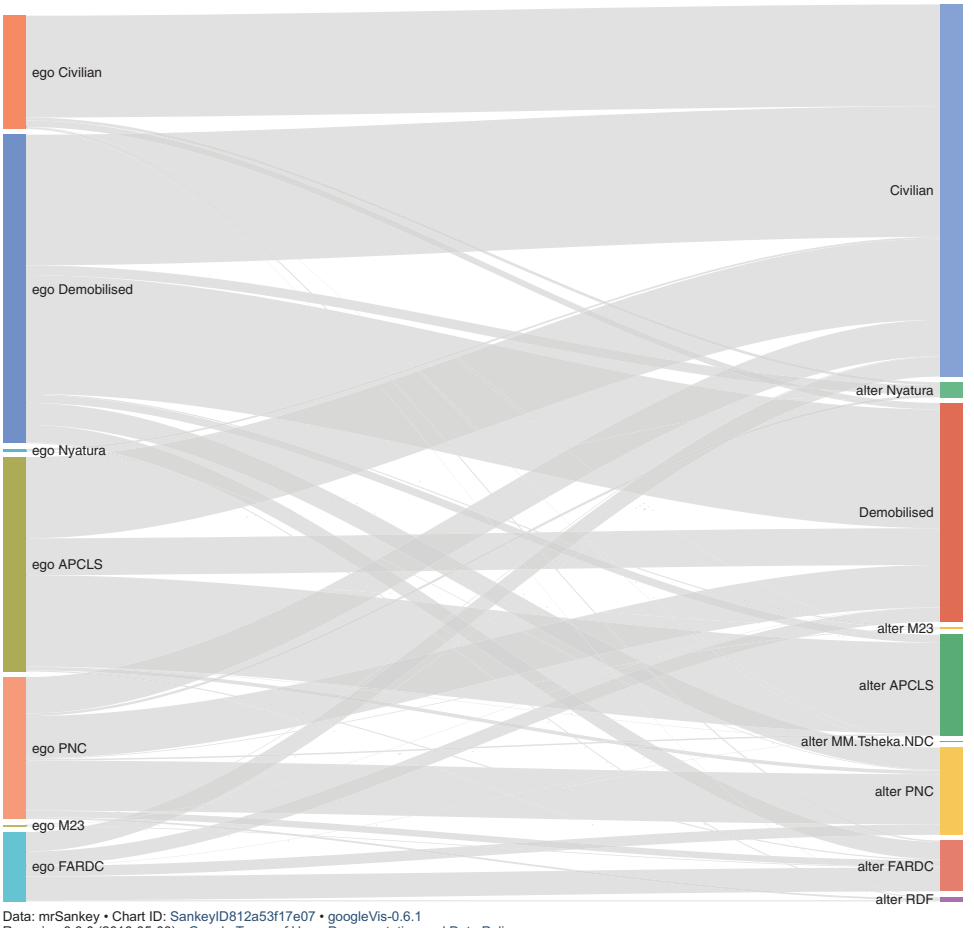

Figure 6. Ego-alter assortativity by active armed group.

There is remarkably little difference in access to different armed groups, defunct or currently active, for different categories. In particular, there is little difference between civilians (top row) and former (second row) and active (third row) combatants, with the exception of the many civilians without any ties to armed groups. This illustrates the highly militarised context – the distinction between demobilised and active combatants is particularly ambiguous.

Whilst the discussion above would suggest that distinct ethno-linguistic subgroups would have different access to armed groups, it seems there is little difference between Hunde and Rwandophones. However, there is a large number of armed groups and Blau's H does not factor in whether most of the diversity is due to homophily or not. As discussed above, armed groups are typically dominated by different ethno-linguistic groups, but our respondents have, generally, the same number of ties to each armed group, accounting for overlapping membership. Thus, none would be in a better position to broker between them, whilst civilians would arguably be in the worst position in terms of such brokerage.

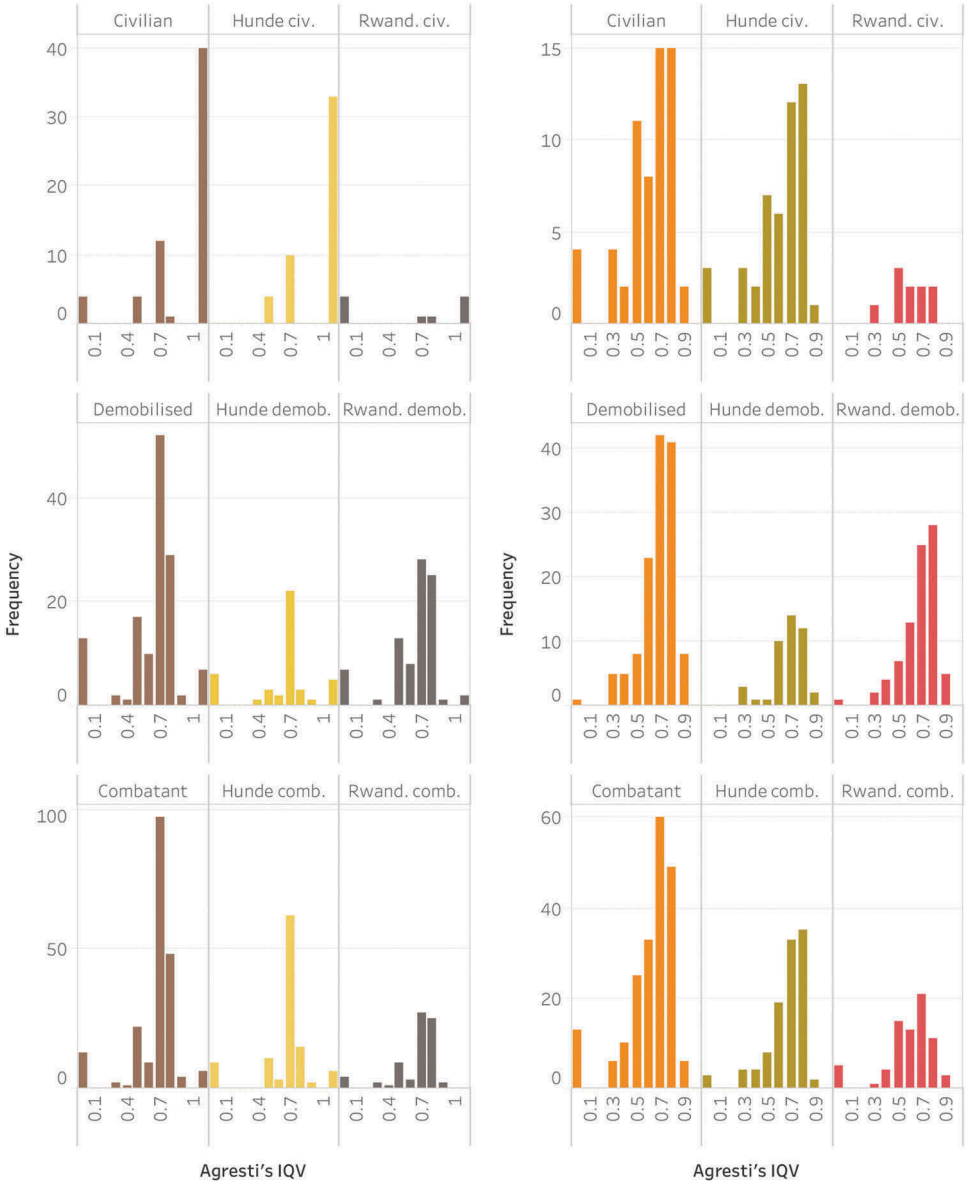

Figure 7. Multilevel brokerage for different subgroups: Access to armed groups (left panels) and Access to livelihoods (right panels).

Armed groups' – and their members' – potential to foment conflict is deeply entangled with access to or exclusion from resources and livelihoods. Thus, individuals who broker between different economic sectors may be as important in terms of conflict resolution as those structurally positioned to broker between armed groups. The right-hand side panels of Figure 7 focus on access to income-generating activities; the figure provides Blau's H (normalised to Agresti's IQV) indices of multilevel brokerage by population subgroup and dominant language group.

Similarly to these groups' access to diverse armed groups, there is little difference in the subgroups' abilities to access various income-generating activities. Civilians, demobilised, and active combatants all secure employment across a variety of markets. Small yet noticeable numbers of civilians and combatants, however, are employed in only one sector, thus not able to broker between different markets due to their lack of access to those employed in them. Due to pervasive poverty and insecurity in the region, and the state's failure to ensure regular and sufficient pay to the police and armed forces, all of them are potential brokers in access to income-generating activities.

Multilevel brokerage – EI

Knowing whether egos can access various armed groups or livelihoods does not elucidate whether they are interacting (or collaborating) with alters different to themselves. To assess this, Figure 8 provides EI indices for the similarity between egos and their nominated alters in terms of their affiliations to all armed groups.

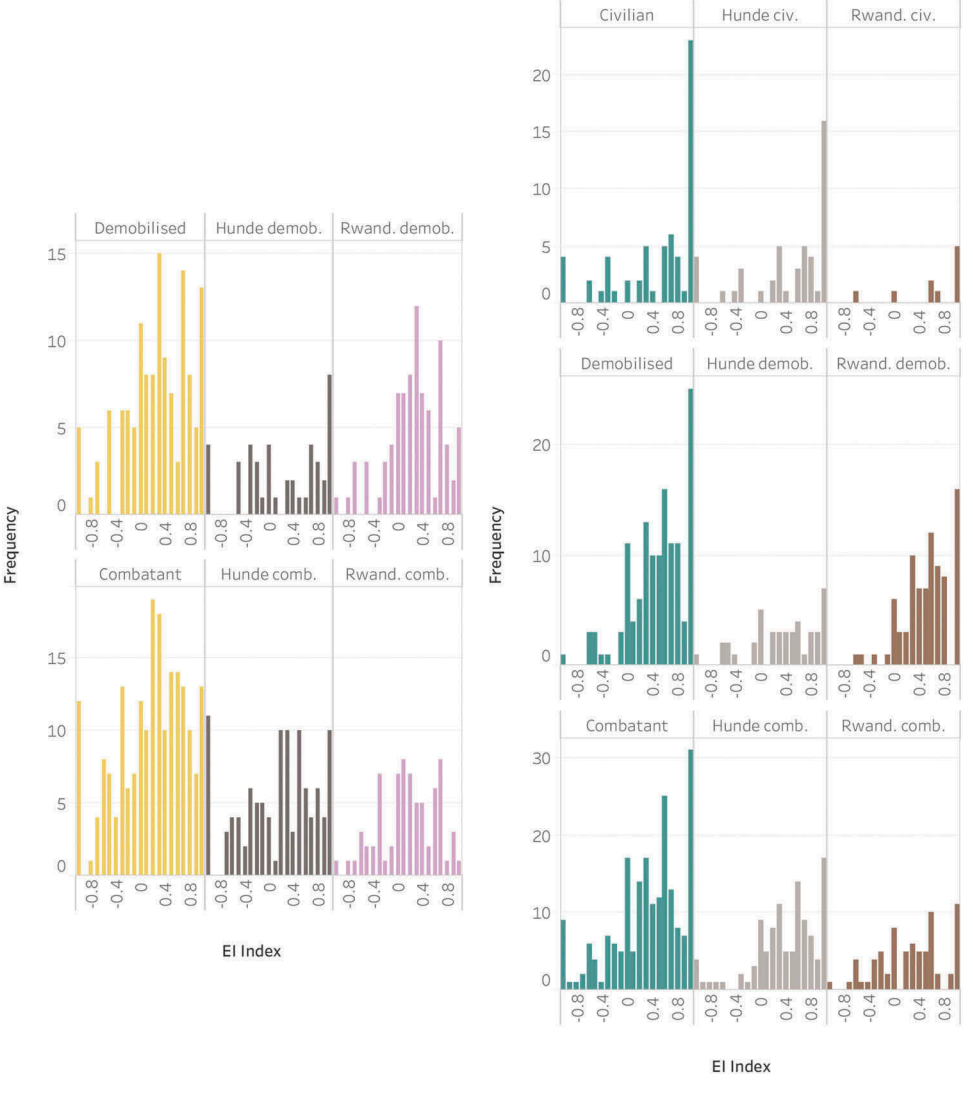

Figure 8. Multilevel brokerage: EI with respect to all armed groups (left panel) and EI with respect to all occupations (right panel).

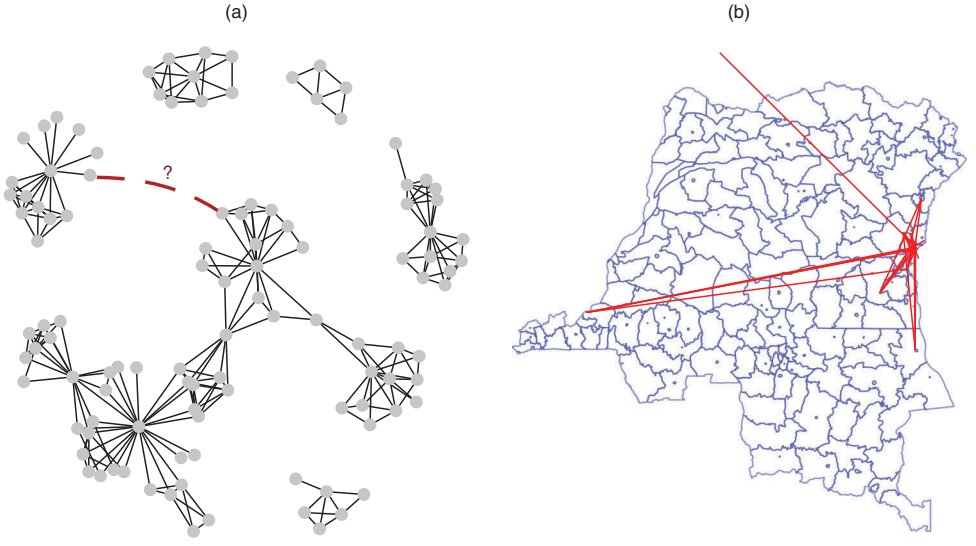

Figure 9. The partial network of the pilot study: Ego-nets of 13 distinct respondents in pilot data with partial overlap (the dashed line indicates an alter-alter dyad that has not been elicited) (left) and Spatial embeddedness of pilot actors (right).

Figure 8 suggests little difference between the categories. Hunde, however, have a tentatively higher tendency towards bimodal EI indices, being split between nominating alters with whom they share armed group affiliations and those with whom they do not. Here, however, the sample is divided between APCLS combatants (majority Hunde) based at the defence position and those clandestinely working in urban areas. Rwandophones seem to have a slightly higher tendency to nominate alters who do not share their own military histories, particularly in reference to those who have demobilised.

The right-hand side panels of Figure 8 assess ego-alter similarity in terms of income-generating activities. Despite similarities between the categories, the vast majority of civilians nominated alters pursuing vocations completely different from their own. This tendency is not as noticeable in the alter nominations of active and demobilised combatants. As in access to different armed groups, demobilised Hunde combatants and active Rwandophone combatants demonstrate a greater bimodal tendency than active Hunde combatants and demobilised Rwandophone ones. Rwandophone combatants, predominantly employed in state police and armed forces, may not be able to access the variety of markets open to Hunde combatants – or failed to disclose this access. Hunde's primary membership in a non-state armed group would enable, and necessitate, the pursuit of various ventures to secure income and their families' livelihoods. In this respect, they may be better able to broker between people working across those sectors, be they civilians, demobilised, or other active combatants.

Summary

The analysis reveals a strong tendency towards homophily, between civilians, demobilised, and active combatants as well as ethno-linguistic groups. The high levels of homophily may confound Blau's H. Respondents who have been members of numerous armed groups and

who pursue a breadth of occupations inevitably have access to many groups. Likewise, the region's long history of protracted, violent conflict translates into a society which remains extremely militarised today, effacing differences we would expect to see between those who are mobilised and those who have demobilised. Membership in some armed groups even entails aspects of civilian life in cities and villages, in service as well as during leave, resulting in confusion of clandestine (and not) combatants with civilians.[82] The fluidity of these distinctions is further supported by cyclic demobilisation and remobilisation or rebranding of armed groups, which likewise aid in explaining active and demobilised combatants' memberships in numerous armed groups.

These dynamics also make it difficult for civilians to live and survive in the area as civilians, disconnected from armed actors and their groups, accounting for their paltry representation in the sample. To protect themselves and their families, many people affiliate with armed groups or are forced to flee insecurity, becoming internally displaced or refugees in neighbouring states. Our sampling strategy, however, may likewise account for the under-representation of civilians.

Rwandophones, overall, appear to have slightly more access to diverse armed groups and occupations than Hunde, but it is necessary to note that the former comprise both Tutsi and Hutu ethnic groups. In popular perception, and particularly in terms of the regiments active in this area, the state security services (FARDC and PNC) are allegedly dominated by Tutsi. The socio-economic and historical cleavages between them and other ethno-linguistic groups in the area may curtail their abilities to broker between them. Membership in the FARDC and PNC restricts access to certain ventures pursued by non-state armed groups, and perhaps its disclosure where it occurs. APCLS, on the other hand, must always engage in various economic activities in order to survive.

Complete network analysis

To parse homophily from differential connectivity and access in the multilevel embeddedness framework detailed above, we apply an exponential random graph model (ERGM) to data including the alter-alter ties that are not represented in Figure 4. We may conceive of the totality of the sample as a partial observation on a multilevel network[83] using A and B – defined as in ***Egos and alters*** above – with the additional adjacency matrix D defining the ties between armed groups. This allows us to model the totality of ties using a multilevel exponential random graph model (MERGM).[84] Drawing on Frank and Strauss,[85] Wang et al. specify a number of different statistics z on the different combinations of ties in A, B, and D.[86] These statistics capture interactions between different types of ties that correspond to meaningful dependencies. We will return to the explicit forms for these interactions after having presented the networks of the subsample.

Pilot data

A subset of the 396-respondent survey was part of the pilot study carried out outside Goma in 2016,[87] yielding the 13 ego-nets in Figure 9 (there are nine components after entity resolution). The sociogram has one annotated example of a dyad where information is missing by design. This is a partial observation on our one-mode network A. The spatial embedding of the network (right panel of Figure 9) suggests that ties cluster geographically.

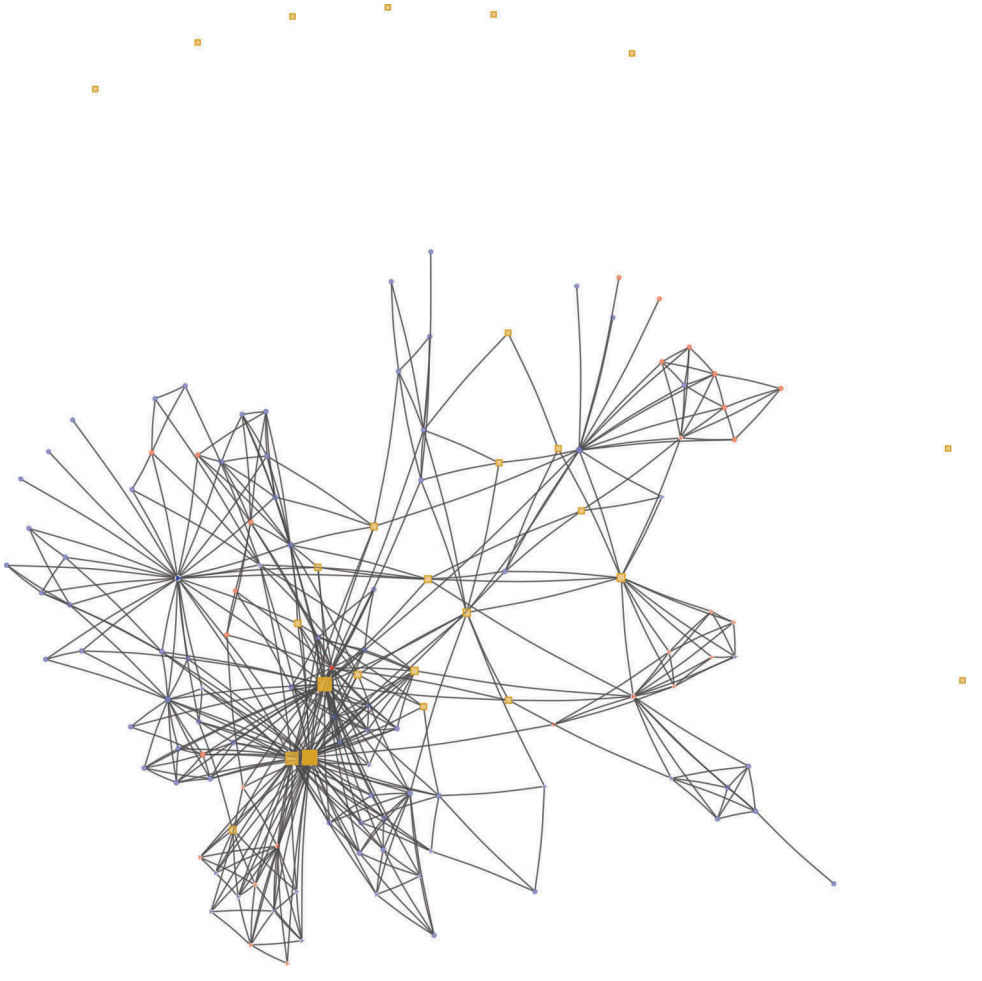

Figure 10. Pilot data represented as multilevel network. Armed groups (square, yellow, size associated with degree) and people (men, blue; woman, red; civilians round; demobilised, triangles).

We identified 26 distinct armed groups that are represented as an affiliation network (B). The network of non-negative ties[88] between the armed groups in the pilot data[89] is a subgraph of Figure 2. Out of the revenue-generating activities reported across the study (see Figure 4) we identified 39 types to include in our analysis after excluding categories captured by armed group affiliation (e.g. 'Police officer' and 'Soldier') and those not relating to primary forms of employment ('Refugee', 'Companion (sex trade)', and 'Other'). We represent livelihoods of individuals as an additional person-by-livelihood affiliation network. Combining A, B, and D yields the multilevel network representation in Figure 10.

Model specification

One-mode statistics $z(A)$ and $z(D)$ are typically defined as in Snijders et al.[90] For example, endogenous degree-based effects are captured by (functions) of counts of different types of

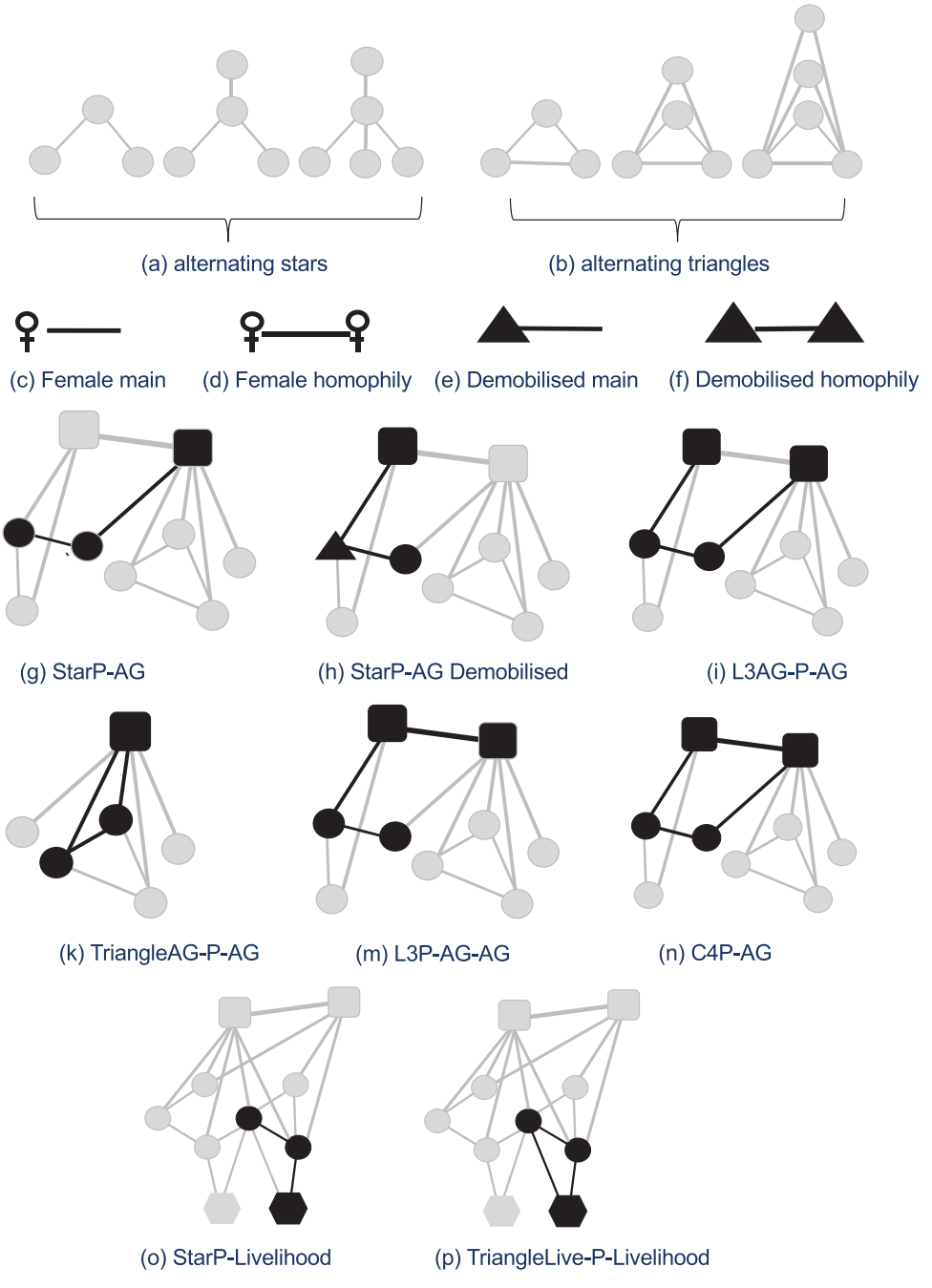

Figure 11. Examples of network statistics: One-mode network and multilevel network configurations in MERGM. Round nodes represent people, square nodes armed groups, six-sided polygons represent livelihoods, and triangles specifically refer to demobilised combatants.

stars.[91] Typically, k-stars (Figure 11(a)) are weighted together using geometrically decreasing weight to form one statistic for the entire degree distribution. These types of configurations may, for example, model mechanisms such as the rich get richer, whereby some nodes tend

to accumulate network ties by virtue of already having many network ties. One-mode ERGM also typically comprise statistics that correspond to triadic closure and mechanisms such as friends of my friends tend to also be friends. The alternating triangle statistic (Figure 11(b)) models the marginal effect on the (conditional) probability that two people will be connected for every additional friend they have in common.

Wang et al. define dependence assumptions and associated statistics $z(B)$ for bipartite ERGM.[92] In our analysis we have chosen not to model affiliations with armed groups and livelihoods but instead treat these as fixed explanatory factors, in which case bipartite statistics are not needed.

Cross-level brokerage or cross-level assortative mixing (Figure 11(g,o)) allows us to study the association between one-mode ties and affiliations. A positive tendency for these configurations would mean that individuals with many personal ties also tend to be affiliated with many armed groups (Figure 11(g)) or many livelihoods (Figure 11(o)), respectively. In this sense, this would mean that there were individuals that indirectly connected many people with many different groups. For armed groups we also include the assortative effect (Figure 11(i)) which models the extent to which actors that are members of many armed groups are also likely to know each other.

Cross-level closure, in the form of a multilevel triangle (Figure 11(k,p)) can be seen as a refinement of homophily. With a positive effect for this cross-level closure, we would infer that people belonging to the same armed group (Figure 11(k)) or livelihood (Figure 11(p)) would be more likely to be connected through a one-mode tie. The exact mechanisms behind this effect could vary depending on the specific context. It can be a matter of latent homophily on shared ideals and beliefs, propinquity, social foci,[93] etc. If two individuals had served in the same armed group together, they would have shared experiences, but this would also mean that they would have had the opportunity to get to know each other in the social setting of the armed group.[94]

Crucial to our understanding of the social fabric in eastern Congo is the complexity of relations between organisations or armed groups (see Figure 2). Knowing that *a* is active in the M23 and that *b* is active in the FDLR entails knowing they belong to opposing organisations and may even have fought one another. If, on the other hand, one person was a member of the RCD and the other was a member of the CNDP (RCD's successor), this might mean that they are more likely to be directly tied because the armed groups are connected (through shared goals, personnel, etc.). The tie between these two people would thus complete the multilevel four-cycle of Figure 11(n). The mechanisms behind this tie-formation effect may differ from the multilevel triangle (Figure 11(k,p)) as propinquity and the opportunity to meet are not directly expressed in the four-cycle.

Nodal properties may be taken into account and included as exogenous predictors of tie-presence. For example, we include an interaction of being female with having a tie (Figure 11(c)) to test whether women tend to have more or less ties than males, all else considered. To test whether people belonging to the same category are more likely to have a tie between them as compared to category-spanning ties we include a statistic for same sex (or female-female) ties (Figure 11(d)). Similarly, for demobilised combatants we include a main effect (Figure 11(e)) and a homophily effect (Figure 11(f)). To distinguish between the role of affiliations with armed groups for active and demobilised combatants, we include the interaction effect 'StarP-AG demobilised' (Figure 11(h)).

A positive parameter for this effect would mean that demobilised combatants would have more social support ties, or be more readily sought out for support, if they have access to many armed groups.

The multilevel ERGM defines a model for the network that has the probability mass function

$$p(A,B,D|\theta) = \exp\{\theta_A^T z(A) + \theta_D^T z(D) + \theta_B^T z(B) + \theta_{AB}^T z(A,B) + \theta_{BD}^T z(B,D) + \theta_{ABD}^T z(A,B,D) - \psi(\theta)\},$$

where $\theta = \left(\theta_A^T, \theta_D^T, \theta_B^T, \theta_{AB}^T, \theta_{BD}^T, \theta_{ABD}^T\right)^T$ is a vector of statistical parameters weighting together the importance of the different types of network configurations, and $\psi(\theta)$ is a normalising constant. A positive (negative) parameter means that there is evidence for a systematic tendency towards (against) the formation of the associated statistic.

Analysis of partially observed network data

In our network some ties are missing by design: ties between alters of different egos are only elicited whenever the alter sets overlap. While we were able to draw conclusions about 'group-brokerage', identifying individual brokers presents issues when networks are partially observed. Consider for example any measure based on reach (e.g. betweenness), which will always be underestimated if there are unobserved ties. Centrality measures, in general, are sensitive to missing data.[95]

The ties of the respondents and the ties between their alters are all known and denoted by W. Ties between alters of different egos are denoted by U. For any realisation u on U, we can recombine the graph $A = (W, u)$ into a complete population and calculate the betweenness scores and other metrics. We can estimate any metric for the complete graph by averaging over potential outcomes of U. Assuming that A follows an ERGM, Koskinen et al.[96] derive the correct distribution for U conditional on us having observed W. This imputation scheme has later been extended to multilevel networks.[97]

MERGM results

We assume a MERGM with the effects of Figure 11 with the addition of a distance effect following Daraganova et al.[98] and Koskinen and Lomi.[99] We use armed group non-negative ties as a predictor, rather than an outcome, kept fixed through the estimation. Similarly, we model the social support network A conditional on the affiliations given the paucity of memberships and the personal histories of the actors.

We followed the inference procedure in Koskinen et al.,[100] using 30,000 iterations in the main algorithm, with 50,000 updating steps for producing each auxiliary variable. For updates of missing tie-variables we used 28,000 updates. Summaries of the posteriors are given in Table 1.

Model I includes one-mode effects and multilevel effects for armed group affiliation. The alternating star and triangle effects suggest that the degree distribution is relatively homogenous and that having indirect contacts (providers of socio-economic support) increases the likelihood of actors being directly tied, respectively. There is evidence of homophily on sex (Female homophily) and being demobilised (Demob homophily) but both categories seem to be less central (Female main and Demob main, respectively). There is a strong effect of distance and, using the interpretation of Daraganova et al.,[101] we might posit that tie-probability decreases with distance according to a power-law.

Table 1. Estimation results: Posterior summaries of parameters in a MERGM fitted to pilot data.

	Model I				Model II			
			95% CI				95% CI	
	mean	sd	0.025	0.975	mean	sd	0.025	0.975
Parameter								
One-mode								
edges	0.959	0.97	−0.781	2.894	1.338	0.973	−0.528	3.328
Alternating star	−2.365	0.253	**−2.861**	**−1.906**	−2.364	0.252	**−2.878**	**−1.882**
Alternating triangle	2.848	0.152	**2.559**	**3.157**	2.798	0.159	**2.485**	**3.1**
Female main	−0.177	0.158	−0.491	0.116	−0.17	0.156	−0.478	0.146
Female homophily	0.76	0.257	**0.242**	**1.262**	0.792	0.27	**0.268**	**1.338**
Demob main	−0.423	0.148	**−0.716**	**−0.138**	−0.876	0.229	**−1.352**	**−0.459**
Demob homophily	0.71	0.258	**0.204**	**1.21**	0.91	0.302	**0.319**	**1.524**
Geo distance	−0.232	0.034	**−0.299**	**−0.167**	−0.222	0.036	**−0.292**	**−0.154**
Multilevel								
Star2P-AG	0.282	0.099	**0.086**	**0.479**	0.184	0.109	−0.043	0.392
Star2P-AG demob					0.149	0.056	**0.043**	**0.261**
L3AG-P-AG	−0.118	0.039	**−0.198**	**−0.044**	−0.11	0.042	**−0.194**	**−0.027**
Triangle AG-P-AG	0.582	0.113	**0.354**	**0.807**	0.663	0.129	**0.41**	**0.913**
L3P-AG-AG	−0.03	0.022	−0.073	0.014	−0.02	0.021	−0.057	0.024
C4P-AG	0.082	0.085	−0.088	0.249	0.029	0.098	−0.169	0.215
Star2P-Livelihood					−0.016	0.005	**−0.026**	**−0.006**
Triangle Live-P-Live					0.876	0.16	**0.555**	**1.191**

Those affiliated with many armed groups have more contacts (Star2P-AG) but not to one other (L3AG-P-AG). Two actors being members of the same armed group increases the likelihood that they are connected (Triangle AG-P-AG), while there is no evidence for alignment between armed group ties and personal support ties (C4P-AG).

In Model II we add the interaction effect of being demobilised and being affiliated with many armed groups (Star2P-AG demob). This effect is positive and its inclusion explains away the base-line effect of having many armed group affiliations (Star2P-AG). Actors who engage in diverse revenue-generating activities have fewer contacts (Star2P-Livelihood) but shared livelihoods increase the likelihood of a tie between two actors.

Accounting for the role of demobilised combatants in Model II we can conclude that while Model I provides weak evidence (C4P-AG is positive with 0.82 posterior probability) of alignment between armed group ties and personal support ties, and strong evidence of membership in many armed groups making actors more connected, both effects disappear when taking into account whether those actors are militarily active or not. Armed groups thus act as foci where personal ties are forged and individuals do not form ties because they share common political goals or aims, as represented by their armed groups being aligned (the absence of an effect for C4P-AG). Being affiliated with many armed groups makes actors less likely to be central in the personal support network unless they are demobilised combatants, in which case it makes them more central. A possible explanation is that active armed group membership monopolises allegiances and only upon demobilisation can one draw on social capital accrued across multiple foci.

Accounting for livelihoods, we can conclude that revenue-generating activities do not facilitate connections to other people, only to those with whom actors share livelihoods. The jack-of-all-trades is central in the personal support network only insofar as they may connect to many people engaged in similar revenue-generating activities, but not by virtue of their versatility in and of itself.

In the course of estimation, the realisations u on U are drawn from the distribution conditional on the sampled data. To check the veracity of the model, it is convention to investigate its goodness-of-fit (GOF) through simulation.[102] We follow Koskinen et al.[103] and compare the augmented observed data with replicates from the model. Figure 12 demonstrates a good fit of the degree distribution.

Brokerage in population graph

The MERGM analysis allows us to ascertain the factors associated with personal support ties while controlling for a variety of other factors. Any individual actor will however instantiate a variety of different attributes and the imputed networks allow us to identify people in our sample that act as multilevel brokers.[104]

Two affiliations that represent a particularly difficult relationship are the APCLS and the M23, respectively Hunde- and Tutsi-dominated armed groups. Aside from the ethno-linguistic groups' historical cleavages of political and socio-economic competition and exclusion, the armed groups have also been in direct conflict on multiple occasions, and in different incarnations. Unsurprisingly, there is no-one who has been a member of both in the pilot dataset. Figure 12 provides the posterior predicted 'brokerage scores' (ordered) for the individuals in the network, based on the imputed population graphs

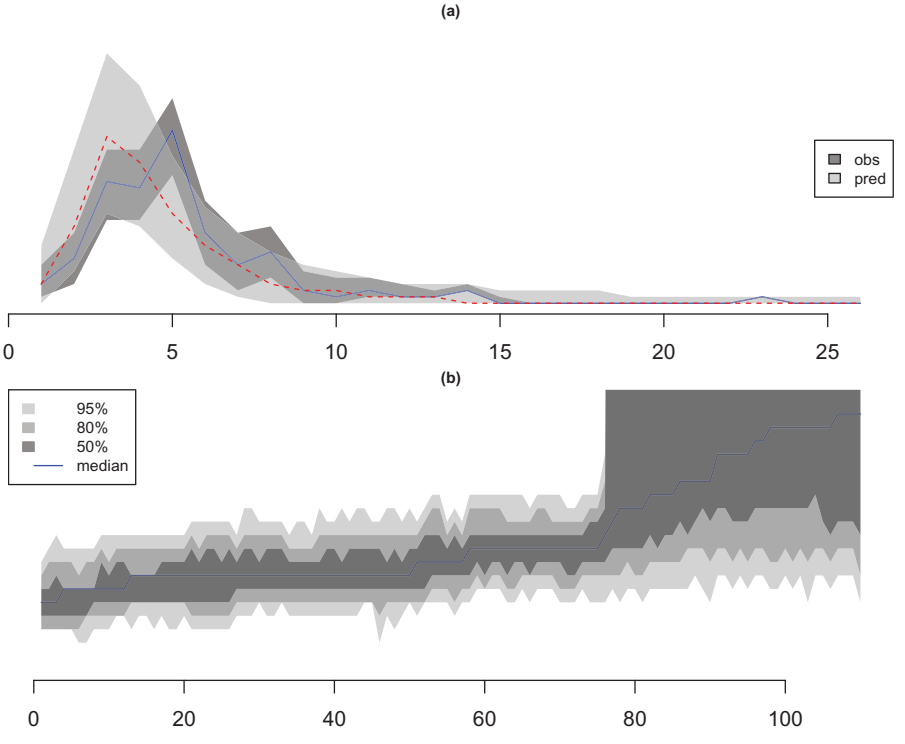

Figure 12. Goodness-of-fit: Comparison of the fitted model to augmented observed network for degree distribution. Posterior predicted brokerage scores for brokering between M23 and APCLS conditional on there existing at least one path. Plot ordered according to posterior median score. Infinite distances set to n. Egos represented as red dots.

(for the 42% of graphs with a path between M23 and APCLS). The scores are calculated as the minimum path length from the focal actor to a member of the APCLS plus the minimum path length from the focal actor to a member of the M23.

The top three median brokers include, respectively, the actor with the most observed ties (a demobilised combatant) but also two actors with low degrees (a civilian and an active combatant). None of them are directly affiliated with either the M23 or the APCLS. Their varied portfolios of experiences allow them to engage with different groups of people, echoing the tentative conclusions of the ego-net analysis.

Summary and future directions

We investigated multilevel brokerage, the extent to which individuals may provide access to different groups through personal support networks in conflict-affected eastern Congo. We found only tentative differences between Hunde and Rwandophone actors but the differences are also confounded to some extent by ethnicity – Rwandophones comprise two often discordant ethnic groups, Tutsi and Hutu, whose belonging and citizenship rights have been violently contested for decades.

The second analysis highlights the complexity of the social context. We build on the concept of multilevel brokerage introduced in the first analysis and posit a model that refines homophily by investigating how the personal support network is embedded in the greater political context. It is clear that demobilised combatants overall broker between the different layers by virtue of having access to many armed groups through previous careers whilst not being restricted by membership in any single current active group. When we identify specific individuals in our dataset that are more likely to be brokers between the extremes of the conflict spectrum – and thus crucial to dynamics of conflict as well as peace – the picture is more nuanced. These individuals are civilians, demobilised, and active combatants. The latter two have complex portfolios of armed group affiliation, linking the domain of the state with a wide range of other groups and their members – active and demobilised combatants. The two analyses utilise different albeit complimentary segments of the dataset; further insights may be obtained from scaling up the second analysis to include all respondents.

Our analyses indicate that the highly militarised context of the region makes distinctions between active and demobilised combatants, and in some cases even civilians, tenuous and ambiguous. As a result of protracted and intractable conflict, most individuals were or remain militarised in some form or another. In addition, armed groups often recruit in the same limited geographical area as where they operate, implying many people have family members, former classmates, colleagues, and neighbours serving in armed groups. Hence, we identified few differences in social support patterns between civilians, demobilised, and active combatants. In particular, it appears that the recourse for civilians is to affiliate themselves – albeit not directly – with armed groups for protection or take up arms themselves. These self-reinforcing mechanisms effectively remove civilians, individuals unconnected to armed groups, from the context whilst exacerbating the institutionalisation of armed groups as means and method of political, economic, and social regulation.

These dynamics, indicated and elaborated upon in our analyses, demonstrate the embeddedness of armed groups in local societies and economies. Our conclusions suggest that the embeddedness of armed groups is so intractable because of the

diversity and complexity of its nature – 'covert' networks are impossible to disentangle from non-covert ones. Likewise, connections between demobilised and active combatants to at least nominally overt actors like state representatives and businesspeople are crucial to understanding the dynamics of regional conflict – and imperative to its resolution. To achieve such understanding, so-called covert networks must be contextualised in the greater networks, overt and not, of which they are part.

Notes

1. Krebs, "Uncloaking Terrorist Networks"; Morselli and Petit, "Law-enforcement Disruption"; Duijn, Kashirin, Sloot, "The Relative Ineffectiveness"; Roberts and Everton, "Strategies for Combating Dark Networks"; Roberts and Everton, "Monitoring and Disrupting Dark Networks"; and Everton, *Disrupting Dark Networks*.
2. Roberts and Everton, "Strategies for Combating Dark Networks"; Roberts and Everton, "Monitoring and Disrupting Dark Networks"; Papachristos and Smith, "The Embedded and Multiplex Nature of Al Capone"; and Diviák et al., "Structure, Multiplexity, and Centrality in a Corruption Network."
3. Everton and Cunningham, "Dark Network Resilience."
4. Newbury, "Ebutumwa Bw'emiogo"; Vervisch, Vlassenroot, and Braeckman, "Livelihoods, Power, and Food"; Vervisch, Titeca, and Vlassenroot, "Social Capital". It should be noted that a large part of the literature solely identifies instrumental and rational motives of armed actors as explanations. See for example "Civil War as State-Making", Stewart's recent application to explaining service provision in Syria. Literature on social capital and the state is extensive, e.g. Narayan-Parker, "Bonds and Bridges", Boege et al., "On Hybrid Political Orders and Emerging States", and Szreter, "The State of Social Capital". Yet as it mostly presents 'social capital' as a metaphor, we chose not to engage with it.
5. Henceforth 'Congo' and in timeless reference to the state's previous existence as Republic of Congo (1960), then Zaïre (1971), subsequently Democratic Republic of the Congo (1997).
6. Verweijen, "Military Business."
7. See Roitman, *Fiscal Disobedience*.
8. Verweijen, "Microcosm of Militarization."
9. Callaghy, *The State-Society Struggle*, 62.
10. See also Vogel and Musamba, "Brokers of Crisis."
11. Hogan, Carrasco, and Wellman, "Visualizing Personal Networks."
12. Wang et al., "Exponential Random Graph Models."
13. Dusenge and Sibomana, *Auto-Organisation des Réfugiés*.
14. See Verweijen, "Stable Instability" and Verweijen and Iguma Wakenge, "Understanding Armed Group Proliferation."
15. Lemarchand, *Dynamics of Violence*; Mararo, "Land, Power"; Muchukiwa, "Territoires ethniques"; and Vlassenroot and Raeymaekers, *Conflict and Social Transformation*.
16. Spitaels, "Transplantation de Banyarwanda."
17. Stearns, "North Kivu" and Mamdani, *When Victims Become Killers*.
18. Mararo, "Land, Power" and Mararo, "Land Conflicts."
19. Mathieu and Tshongo, "Guerres Paysannes."
20. de Villers and Tshonda, "An Intransitive Transition."
21. UNOHCHR, "Mapping Exercise."
22. From 'water' in Swahili and in reference to a ritual believed to make fighters invincible.
23. Van Bockhaven, "The Leopard Men."
24. Stearns, *Dancing in the Glory*.
25. Lanotte, *République Démocratique du Congo*.
26. Stearns, "From CNDP to M23."
27. UNSC, "Midterm Report S/2013/433."

28. Maps sourced from Reuters/Reuters Graphics, "Congo's Cycle of Rebellion."
29. Verweijen and Iguma Wakenge, "Understanding Armed Group Proliferation" and Vogel and Stearns, "Kivu's Intractable Security Conundrum."
30. Stearns, Verweijen, and Eriksson Baaz, "The National Army."
31. Stearns and Vogel, "Landscape of Armed Groups."
32. Bafilemba and Mueller, "Networks of Eastern Congo's."
33. The base source for the figure is information coded from Bafilemba and Mueller, "Table"; Vogel, "Armed Groups"; Vogel and Stearns, "Kivu's Intractable Security Conundrum"; Vogel and Musamba, "Brokers of Crisis"; Verweijen, "The Ambiguity of Militarization"; and the references therein. Data for the armed groups relevant to the analysis in Section 'Complete network analysis' has been augmented by area experts Stys, Verweijen, and Vogel, drawing on "Groupe Armé "NYATURA"'; Vlassenroot, Mudinga, and Hoffmann, "Contesting Authority"; Mararo, "Le TPD à Goma"; and Vogel, "Armed Groups". A summary for select groups is provided in Table A.1. The sizes, provenance, and relations among the groups are incomplete and approximate. Further research is needed to gain a more accurate picture.
34. A simplified account of how groups are related over time is provided in Table A1. in the Appendix.
35. More details are provided in Stys et al., "Technical Brief: DR Congo."
36. Data collection was in rural eastern Congo. Available electricity was limited to two hours per day, using a rented generator – the only time when laptops, tablets, and mobiles could be charged. The majority of road access to field sites was unpaved dirt roads or hilly trails. Project overseen and implemented by Papy Muzuri Batumike, Jean Luc Kikumu, Keith Samuel Muhindo Balume, Patrycja Stys, and four researchers whose preferences concerning acknowledgement could not be determined by the time of submission (data collected Jul.-Oct. 2016).
37. The seed set was composed of representatives from the populations of interest who were community leaders, understood the project, consented to participation, and could vouch for the project vis-à-vis their constituencies. They represented demobilised and active combatants and civilians, both men and women.
38. Thompson and Frank, "Model-Based Estimation"; Handcock and Gile, "Modeling Social Networks".
39. Koskinen et al., "Bayesian Analysis" and Koskinen et al., "Statistical Analysis."
40. Van der Poel, "Delineating Personal Support Networks."
41. McCallister and Fischer, "Surveying Personal Networks."
42. Thoits, "Social Support."
43. See note 11 above.
44. Stys et al., "Technical Brief: DR Congo."
45. Ibid.
46. As Tutsi and Hutu both have Kinyarwanda, including its dialects, as mother tongue, it is impossible to differentiate between them beyond the language group 'Rwandophone'; the term 'ethnicity' refers here exclusively to these language or ethnolinguistic groups.
47. Hobsbawm, "Are All Tongues Equal?"; Cornell and Hartmann, *Ethnicity and Race*; Anderson, *Imagined Communities*; and Berman, "Ethnicity, Patronage."
48. Hoffmann and Vlassenroot, "Armed Groups."
49. Brett, "Rebuilding War-Damaged Communities" and Berman, "Ethnicity, Patronage."
50. For a breakdown of armed group membership by language group and sex see Table A2 in the Appendix.
51. Eriksson Baaz and Verweijen, "Between Integration and Disintegration."
52. Baker and Faulkner, "The Social Organization of Conspiracy"; Krebs, "Mapping Networks"; Carley, Lee, and Krackhardt, "Destabilizing Networks"; Crenshaw, "The Logic of Terrorism"; Jackson, Herbrink, and Jansen, "Examining Criminal Organizations"; Westlake, Bouchard, and Frank, "Key Players"; Koschade, "Analysis of Jemaah Islamiyah"; Lindelauf, Borm, and Hamers,

"Influence of Secrecy"; Raab and Milward, "Dark Networks as Problems"; and Sparrow, "Criminal Intelligence."

53. Helfstein and Wright, "Covert or Convenient?"
54. Of course, the drawbacks of a narrow focus on centrality measures are well known in the literature on illicit networks, see for example Roberts and Everton, "Monitoring and Disrupting Dark Networks."
55. Morselli, "Vulnerable and Strategic Positions"; Morselli, Giguère, and Petit, "Efficiency/Security Trade-Off"; and Morselli and Petit, "Law-Enforcement Disruption."
56. Morselli, Giguère, and Petit, "Efficiency/Security Trade-Off."
57. Bright, Greenhill, and Levenkova, "Node Attributes" and Qin et al., "Analyzing Terrorist Networks."
58. For useful conceptual clarifications regarding the nature of covert ties, see: Oliver et al., *Covert Networks* and Campana, "Explaining Criminal Networks."
59. Notable exceptions include studies which infer tie-formation mechanisms consistent with local preferences for retaining efficiency whilst remaining secret: Diviák, Dijkstra, and Snijders, "Efficiency/Security Trade-Off" and Bright, Koskinen, and Malm, "Illicit Network Dynamics."
60. The role of overt ties is discussed in Giménez-Salinas, "Criminal Organizations" and Everton and Cunningham, "Dark Network Resilience", which elaborate on the role of external ties for resilience in the context of the security/efficiency trade-off and operational targets. More generally, Gerdes, "Dark Dimensions"; Papachristos and Smith, "The Embedded and Multiplex Nature of Al Capone"; and Diviák et al., "Structure, Multiplexity, and Centrality," all discuss the relation between overt and covert ties in terms of multiplexity.
61. Carley, Lee, and Krackhardt, "Destabilizing Networks"; Cockbain, Brayley, and Laycock, "Child Sex Trafficking"; and Crossley et al., "Covert Social Movement Networks."
62. Horgan and Taylor, "Provisional Irish Republican Army" and Gill et al., "Lethal Connections."
63. See note 8 above.
64. See note 6 above.
65. Verweijen, "The Ambiguity of Militarization."
66. Vogel and Musamba, "Brokers in Crisis," makes the argument that whether the ties are covert or not is spatio-temporarily determined.
67. Krebs, "Mapping Networks" and Reed, "Understanding an Insurgency."
68. Burt, *Structural Holes*.
69. Gould and Fernandez, "Structures of Mediation."
70. Hollway and Koskinen, "Multilevel Embeddedness."
71. Everett and Borgatti, "Overlapping Categorical Attribute Data."
72. See DiMaggio, "Classification in Art."
73. See Snijders, Lomi, and Torló, "Multiplex Dynamics of Two-Mode."
74. See note 71 above.
75. Everett and Borgatti, "Dealing with Overlapping."
76. Lazega et al., "Catching Up with Big."
77. See note 71 above.
78. Ibid.
79. Figure A1 in the Appendix.
80. Had we taken a simple random sample of dyads from the population, the diagram would have been perfectly symmetric, up to sampling error.
81. The index, or one minus the index as originally defined by Simpson, "Measurement of Diversity," has been referred to as Simpson index, the Gini-Simpson index, Gibbs-Martin, or Herfindahl index depending on discipline (M. Everett, 'Personal Communication,' 2018).
82. Muzuri, "A Never-ending Story."
83. Koskinen et al., "Bayesian analysis of ERG models for multilevel, multiplex, and multi-layered networks with sampled or missing data."
84. See note 12 above.
85. Frank and Strauss, "Markov Graphs."

86. See note 12 above.
87. Pilot participants were: active combatant men (6); demobilised men (2) and women (4); civilian man (1).
88. Non-negative ties are defined as mergers (de jure and de facto), splits, collaborations, and predominantly non-hostile/violent dynamics between armed groups, temporally restricted to periods of their coexistence; in no instance do the general dynamics account for those of their full membership. Mayi-Mayi Kifuafua, as per respondents' military histories, refers to the Katuku of the 1990s.
89. Coding completed by area experts Stys, Verweijen, and Vogel, drawing on "Groupe Armé "NYATURA"'; Vlassenroot, Mudinga, and Hoffmann, "Contesting Authority"; Mararo, "Le TPD à Goma"; and Vogel, "Armed Groups."
90. Snijders et al., "New Specifications for Exponential."
91. See note 85 above.
92. Wang et al., "Exponential Random Graph (P□)."
93. Feld, "The Focused Organization."
94. In general it seems an intractable problem distinguishing between the extent to which shared settings act as actual meeting places or mere co-affiliations in absolute terms. Belonging to the national army (FARDC) clearly would be a weak affiliation due to the sheer number of active combatants. The number of active combatants of the recognised rebel groups in Figure 2 do however range in the hundreds rather than thousands (see Table A1).
95. Costenbader and Valente, "Stability of Centrality Measures" and Borgatti, Carley, and Krackhardt, "Robustness of Centrality Measures."
96. Koskinen et al., "Bayesian Analysis."
97. See note 83 above.
98. Daraganova et al., "Networks and Geography."
99. Koskinen and Lomi, "The Local Structure of Globalization."
100. See note 83 above.
101. See note 98 above.
102. Robins, Pattison, and Woolcock, "Small and Other Worlds"; Hunter, Goodreau, and Handcock, "Goodness of Fit"; and Robins and Lusher, "Illustrations."
103. Koskinen, Robins, and Pattison, "Analysing Exponential Random Graph."
104. Koskinen et al., "Outliers and Influential Observations", recently developed a measure of outliers or 'extreme actors' that aims to identify influential individuals. It would have been appropriate here but is not directly applicable to partially observed networks.

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Appendix

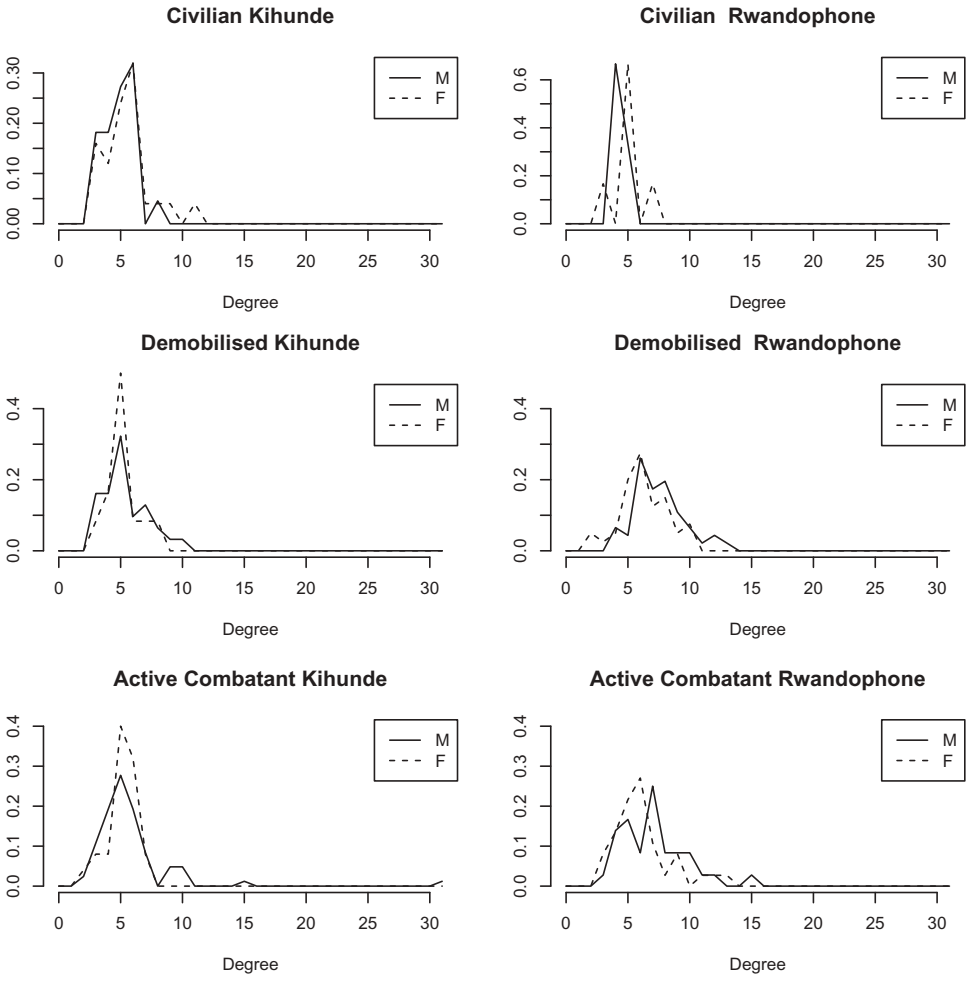

Figure A1. Degree distributions of alters by population subgroup, language group, and sex.

Table A1. Approximate size, origin, and successor of armed groups in and around Masisi territory and used in Figure 2 (estimated for 2013).

Armed Group	Troop Size	Created	Successors	Predecessors	Splinters
APCLS	1000	2008	N/A	PARECO, MM Janvier/PCLS	APCLS-Rénové (Mapenzi & Poyo)
Guides-MAC	200	2010	N/A	Guides	FDC-Guides
FDC-Guides	100	2012	N/A	Guides	Guides-MAC
FDLR (FOCA)	2000	2000	CNRD	ALiR	RUD, Soki, Mandevu
RUD-Urunana	400	2004	FPP(H)	FDLR	N/A
FDLR-SOKI	50	2006	'Kasongo'	FDLR	N/A
FPD-Shetani	100	2009	Mayi-Mayi Charles	FARDC	N/A
Coalition Raia Mukombozi	300	2012	RM Donat/Ngandu and others	Mudundu 40, Raia Mutomboki, Mayi-Mayi Padiri	RM Mabala, RM Maheshe, RM Makombo
M23	1300	2012		CNDP, RCD-Goma	Bosco group
Mayi-Mayi Kifuafua	300	2002	N/A	Mayi-Mayi Padiri, Katuku, Batiri	Maachano, Limenzi, Delphin, Shalio
Nduma Defence of Congo	400	2009	NDC-Rénové	Mayi-Mayi Kasikila	NDC-Rénové
Nyatura-FDIPC	200	2013	FARDC, FPP(H)	PARECO?	FPP
Nyatura-FODP	200	2012	Muchoma, Nyatura-Domi	PARECO	Nyatura Ngwiti, Vutura
Nyatura-MPA	200	2011	FARDC, FPP(H)	PARECO?	FPP
Nyatura-FDDH	200	2011	Groupe de Securité, Nyatura-Kavumbi	PARECO	Nyatura-Bigirabagabo
Nyatura-Delta	500	2011	N/A	PARECO	N/A
Nyatura-Noheri	100	2013	FDDH, APRDC/CMC	PARECO	
RUC-Bapfakururimi	200	2011	Nyatura Domi, Nyatura Muchoma	PARECO	
URDC	200	2012	FARDC?	RCD-K/ML	
UPCP-Lafontaine	200	2011	UPDI, Mazembe, FPP-Kabido	PARECO	
FARDC	100,000	2003	N/A	FAC, FAZ	
CNDP	-	2004/6	FARDC/M23	RCD-Goma	Busumba LDF
Busumba LDF	50	2012	Nyatura Jean-Marie	RCD-Goma, CNDP	

Source: See note 33.

Table A2. Armed group membership by language group and sex.

Armed Group	Sex	Kihunde	Kinde	Lingala	Mashi	Rwandophone	Other	Total
RCD	W	8		1		37		46
	M	7	1	1		41		50
CNDP	W	2		1		36		39
	M	6	1			36		43
Nyatura	W	1		1		4		6
	M	2				1		3
MM Janvier	W	10				1	1	12
	M	28	1	1	1	1		32
MM Kifuafua	W	4						4
	M	15	1					16
AFDL	W	1		1		9		11
	M	3	1	1		20		25
RPA	W					5		5
	M		1			11		12
PARECO	W	2					1	3
	M	9			1	2		12
MAGRIVI	W			1			1	2
	M	6				2		8
FDLR	W			1			1	2
	M					1		1
MM Bangilima	W							
	M	1						1
MM Tsheka NDC	W					1		1
	M	1						1
MM Shetani	W							
	M		1			1		2
MM La Fontaine	W							
	M		1			1		2
TPD	W			1				1
	M					8		8
RDF	W							
	M					1		1
APCLS	W	3				2		5
	M	22		1		3		26
M23	W					3		3
	M					3		3
FAZ	W					1		1
	M					1		1
FAC	W							
	M	2				1		3
FARDC	W	2		1		2		5
	M					3		3