AN ECOLOGICAL PERSPECTIVE ON POLITICAL VIOLENCE: THE ROLE OF CULTURE, NETWORKS, AND AFFILIATIONS

A Dissertation

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Doctor of Sociology

by

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August 2014

AN ECOLOGICAL PERSPECTIVE ON POLITICAL VIOLENCE: THE ROLE OF CULTURE, NETWORKS, AND AFFILIATIONS

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Cornell University 2014

The dissertation addresses a number of core questions about terrorism: why do some terrorist organizations, and not others, adopt the devastating tactic of suicide bombing? What contextual factors predict self-starter terrorism, meaning political violence that occurs without the assistance or direction of a pre-existing terrorist organization (e.g. the Boston Marathon bombers)? How are one's social networks affected by one's position in an affiliation ecology (McPherson 1983), and how do positions in affiliation ecologies affect recruitment into terrorist organizations? To address the first question, I apply event history models to a global dataset that includes all recorded suicide bombing attacks from 1981-2006. I show that organizations embedded in collectivist cultural ecologies are far more likely to use suicide bombings than organizations embedded in individualist cultural ecologies, conditioning on factors suggested by alternative explanations. To assess self-starter terrorism, I develop an agent-based model, grounded in empirical data that identifies the mechanisms by which the network ecology promotes and constrains terrorist mobilization. The model is also able to distinguish the manner in which self-starter terrorism is carried out − whether by lone wolves or by small groups. To assess the relationship between affiliation ecologies and terrorist recruitment, I first generate a theoretical framework I term "Blau Status Analysis", which extends McPherson's (1983) approach to individual-level actors. Using the Add Health dataset, I validate the framework by showing that Blau statuses are associated with a variety of network properties. I then apply the framework to show how affiliation ecology affects recruitment into covert organizations. I conclude by discussing additional research veins in political violence that can be exploited using the ecological perspective as well as the theoretical and methodological contributions the dissertation made to questions of general interest to sociology.

BIOGRAPHICAL SKETCH

Michael Genkin received a Baccalaureate of Arts degree, summa cum laude, from the University at Albany, State University of New York, in sociology and philosophy. He received his Masters of Arts degree in sociology from Cornell University. Michael's research deals with questions fundamental to sociology and arguably to almost every social science discipline: what are the conditions and mechanisms that produce solidarity and conflict in human societies? His areas of expertise include social network analysis and political violence. Michael's most recent work has appeared in the *Journal of Conflict Resolution*.

I dedicate this dissertation to my late grandfather Yosef Osipovich Boydik, to my parents Irina and Lev Genkin, and to the many teachers and professors that have mentored me and contributed to my intellectual development.

ACKNOWLEDGMENTS

I would like to acknowledge the guidance, help, and useful suggestions of my advisors Drs. Matthew Brashears and Michael Macy and my other committee members Drs. Mabel Berezin, and Edward Lawler. I would also like to acknowledge the help and intellectual stimulation from fellow PhD students and colleagues: Robert Braun, Alexander Guttfraind, Chan Suh, and Yongren Shi. However, I take full responsibility for any unwitting imperfections, mistakes, or other deficiencies found in this dissertation.

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INTRODUCTION

The dissertation considers the role that three kinds of ecology play in generating politically-motivated violence. The first part considers the role of cultural ecology in the diffusion of suicide bombings, using an event history analysis framework. The second part investigates the phenomenon of self-starter terrorism. Using an agent-based model, grounded in empirical data, the chapter identifies the mechanisms by which the network ecology promotes and constrains mobilization into self-starter terrorism as well as the manner in which it is carried out. The third part proposes a theoretical framework I term "Blau Status Analysis" and investigates how one's social networks are influenced by one's position in the affiliation ecology. This general framework is first validated using the Add Health dataset and then applied to a membership of a covert organization, showing how affiliation ecology can be used to explain and predict recruitment into a terrorist organization.

But before I begin I would like to explain what I mean by the term "ecology". Like many social scientific terms, "ecology" does not have a single accepted meaning. I would like to briefly review some of the ways scholars have thought about ecology and the way I plan to use the term in the context of the dissertation. I conclude by explaining why the ecological approach is needed and useful in explaining terrorism and political violence.

Ecology in Social Science

The term "ecology" was first introduced into sociology by the Chicago School and its associated scholars – Robert E. Park, Ernest W. Burgess, and Roderick D. McKenzie. The term was borrowed from biology. Attempts at biological accounts of animals were initially focused on the animals themselves. One might describe the behavior of a horse compared to a zebra by

focusing purely on the animal's phenotype. At the time of the beginning years of the Chicago

School, which was the 1920s, a major recent theoretical framework that was being elaborated in

field of biology was the ecological approach. Its central idea is that the animal is embedded in a

larger system that includes the particular distribution of co-species, food resources, and

predators. Understanding the position of the animal in respect to this larger system is just as

critical in understanding its behavior as cataloguing its internal characteristics (which themselves

may be a product of the environment). The ecological approach in biology was thus concerned

with understanding how the organisms interact with one another and with their environment. For

the Chicago School the metaphor of ecology was particularly useful because it could be

profitably applied to the social realm (Gaziano 1996)[1] and to the urban sociology research

program they were developing (McKenzie 1924; Park, Burgess, and McKenzie [1925]1967).

This was because the city had many analogs to the biological organism, with areas that

differentiate each other (a la tissues), grow, and fall in and out of equilibrium. Newcomers and

immigrants are *metabolized* into the city. There is a measurable *pulse* that different areas of the

city have in terms of the circulation of people (a la blood in the human body) (Park, Burgess, and

McKenzie [1925]1967). McKenzie argued that we needed to understand the "ecological basis of

the community", which meant understanding how factors such as the size of a community or the

internal structure of the community were the consequences of internal competition for resources

(McKenzie 1924). A key idea was that the micro environment – the context – in which social

life unfolded was critical. This context could be the city, the neighborhood, the tenement house,

or the school. Rather than abstracting it away as noise, ecologists explicitly sought this context

out as part of the explanans. However, many critics noted the waters got muddied and many

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[1] In fact there were biologists who were actively encouraging the metaphor viewing humans as another community of animals inhabiting the biome (see Gaziano 1996 for a great review).

studies were carried out under the ecological banner without a clear theoretical import (Gaziano 1996; Hawley 1944)

The next big resurgence in ecological thinking came after World War II by McKenzie's student Amos Hawley. He noted that two camps have formed around the ecology banner, with the difference being in how closely to adhere to the biological analogy. Hawley himself advocated moving away from some of the biological metaphors – particularly the previously central notion of competition (Hawley 1944). He argued that the problem of ecology is to study how human populations adjust to the conditions of their environment. Practically it meant looking at causes that are outside individual-consciousness and focusing on how communities are affected by size, rate of growth, and changes in population compositions (ibid)[2]. One important theoretical wrinkle is that a big part of the analysis involved identifying points of equilibrium between the actors and their environment and explaining outcomes by showing how they are due to the system being in or out of equilibrium.

Other disciplines have developed their own theoretical agendas around what constitutes ecology, most notable are human geography and anthropology (Cronk 1991; Scoones 1999). Sub-specialties in sociology have also appropriated the term, the most prominent being population ecology (Hannan and Freeman 1989) and affiliation ecology (McPherson 1983). Concepts that seek to characterize the environment using biological terms such as niches, carrying capacities, competition and selection are used by some ecological approaches but not by others. The common thread to all ecological conceptions is that they are system-level accounts. This is the point of departure on which I build my own conception of ecology.

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[2] In fact the project he was advocating looks a lot like modern demography.

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Ecological Thinking is Systems Thinking

Like many concepts in social science, "ecological" is a term that is currently used in multiple ways. Therefore it is important for the analyst to define exactly what they mean by the term and how they are using it. My definition incorporates two elements from the earlier ecological theorists.

First, an "ecological explanation" puts the explanans at the environment of the individual or more precisely at the system-level, rather than the individual level. The causal mechanism therefore crosses levels of social organization. The contrasting mode of analysis is linear or reductionist thinking of breaking things apart and explaining them from the properties of the elements or the equal sums of those properties. To think in terms of systems does not mean that human agency is irrelevant, that humans are blank slates with little variation, or that things are determined and people are mere "cogs in the machine"[3]. Instead thinking in terms of systems means paying attention in how individual-level action could be made more or less likely by interactions at the higher-level of aggregation. For example a man who is unemployed might explain the predicament by appealing to a mismatch in his skills and the jobs available. A systems account might consider the deeper forces driving supply and demand such as vacancy chains that are linked to policy on retirement age as well as the age of the current occupants.

Second, there is an emphasis on the dynamical aspect of the system where the movement produces cascading effects beyond the elements that are moving. The analyst must look for emergent properties and interdependencies between elements of different units of aggregation.

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[3] The old debate between methodological individualists and methodological holists does not directly map on here. Some explanations are most appropriate as bottom-up explanations and some can include higher levels of aggregation. All social analysts should consider larger systems. For example for methodological individualists this would mean considering how the system creates incentives and disincentives for action.

The goal is to see how elements fit in on a larger scale. The contrasting case is to think in terms of static structures or conditions where an increase in some variable creates a linear increase/decrease in a corresponding variable. Properties in this case are additive rather than emergent.

The ecological approach is desirable because it provides greater analytic leverage to explain the complexity of the social world. While sociological theory has generally acknowledged that human action is interdependent, it is only recently that this insight has been theoretically and methodologically elaborated[4]. Recent advances in chaos theory and complexity theory have shown persuasively that a great deal of social phenomenon at the macro-level may be understood by modelling interactions at the micro-level (Macy & Willer 2002). Indeed inter-dependencies exist at multiple-levels and should be taken into account to the extent possible. Part of the motivation for social network analysis is precisely this insight as human beings do not act as independent actors. Instead they are embedded in relationships that constrain and promote the choices they make (Granovetter 1985). Because of these inter-dependencies most social relationships are not linear and emergent properties permeate social life (Abbott 1988).

The three papers presented here are all ecological because they consider system-level, dynamic explanations and how interactions or properties at the higher level affect lower-level outcomes. The first paper consider how the process of diffusion is affected by the cultural context in which the adopters are embedded. The second paper constructs an agent-based model on how the network structures interact with the larger environment to match individuals with hidden traits. The final paper lays out a theoretical framework for the kinds of positions that the

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[4] Moreover, while some sociologists pay homage to the interdependence of human action, they abstract away this interdependence when actually modelling the phenomenon of interest. Part of this is due to data limitations, but a great deal is not. A good example are papers that use Add Health (which has full socio-metric data) but that do not control for any network effects.

environment saturated with competing organizations creates and how the conventional affiliation ecology can be extended to the individual level.

The Ecological Approach to Terrorism

As I lay out in each chapter the ecological approach is severely lacking in how scholars approach my substantive area of interest, which is terrorism and political violence. The specialty suffers an intellectual selection problem. Sociologists form a minority among the scholars of terrorism and the approaches that dominate tend to reflect the disciplinary biases of the researchers. Psychologists and political scientists predominate. Explanations tend to be individualistic and reductionist[5]. Each of the topics selected for the three papers illustrates this point and presents

Understanding suicide bombings is often done by interviewing failed suicide bombers, coding video testimonials, and cataloguing the plethora of motives that the bombers use as rationalizations for their actions. Other researchers try to identify ideological motivations or organizational features of the groups that dispatch them.

Self-starter terrorism is similarly overly focused on radicalization and the individual risk factors that drive people to commit acts of violence. There is a similar reductive approach in trying to understand the psychology instead of the larger system in which self-starter operates and how it mobilizes into action.

Finally recruitment into terrorist organizations is viewed from a profiling perspective. Persons who possess certain demographic attributes are viewed as more likely to engage in terrorism. The profiling approach is not only unsuccessful in identifying true terrorists but has

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[5] There are however clear exceptions to this. I do not mean to imply that all political scientists and psychologists think the same or are not open to alternative interpretations. I am simply pointing to an observed trend.

also sometimes ensnared innocent individuals. A nice illustration of how profiling failed to screen out terrorists is the Dailey Anti-Hijacking System developed in the late 1960s when the United States was hit by an epidemic of aerial hijackings (Koerner 2013). The system was developed by the psychologist John Dailey after he reviewed more than 70 cases and compiled highly complex personality, demographic, and behavioral profiles on the hijackers involved (ibid). Dailey's system was a resounding failure. Out of 226,000 passengers, his system picked out 1268 for additional questioning of which 24 were subsequently arrested (ibid:68). After a few high profile cases, the airline industry was forced to accept the closer supervision of passengers by the FAA, metal detectors, and rules on air travel.

An economist who conducted a study by seeking to identify the unique features of home-grown terrorists concluded: "The analysis also highlights the difficulty of identifying terrorists from their demographic characteristics. The relatively low R-squares suggest that participation in terrorism has a large unpredictable component." (Krueger 2008:296)

What this dissertation aims to show is that much explanatory leverage can be gained over political violence by thinking bigger, by considering the larger environment and the critical elements therein. By analyzing the role of culture, the role of networks, and the role of affiliations I hope to make a case for the ecological perspective on terrorism.

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CHAPTER 1: DIFFUSING HUMAN BOMBS: CULTURAL RESONANCE AND THE SPREAD OF SUICIDE TERRORISM[1]

On December 15, 1981 a driver of a car packed with explosives rammed his vehicle into the Iraqi embassy in Beirut, Lebanon killing himself as well as the Iraqi ambassador and 61 persons, while also injuring more than 100 others. This event is generally considered as launching the modern era of organizational suicide terrorism (Moghadam 2009; Pedahzur 2006). While the overall level of terrorism[2] has declined over the last two decades, the world has witnessed a steep increase in suicide attacks by sub-state actors (Atran 2006:131). This increase of self-sacrificial violence has resulted in enormous human suffering. Suicide attacks accounted for more than 50,000 casualties[3]. The number of terrorist organizations adopting the tactic as part of their arsenal has been climbing rapidly (see Figure 1). Yet, this increase has not been uniform – some terrorist groups have adopted the tactic while others have not. We argue that suicide bombing diffusion follows a unique cultural pattern and that the study of the spread of this extreme innovation uncovers deeper lessons in how culture affects diffusion.

By examining the shortcomings of existing perspectives that attempt to explain the spread of suicide bombings we propose an alternative that suggests a useful way of rigorously incorporating the role of culture (specifically cultural orientations) into diffusion scholarship. Culture has long been considered central to conflict studies but has not been incorporated in a rigorous way due to both conceptualization and operationalization difficulties. To assess the

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[1] A paper is based on this chapter co-written with Robert Braun and forthcoming in the *Journal of Conflict Resolution*. The title of the paper is "Cultural Resonance and the Diffusion of Suicide Bombings".

[2] As has been widely noted the term "terrorism" has no universal scholarly agreement regarding what type of activity falls under its purview. For the purposes of this paper we use it to refer to a tactic by social movement organizations that pursue political goals using deliberate violence as their primary tactic and targeting primarily civilian populations. For a discussion of other conceptualizations see Walter (1964); Gibbs (1989); Ganor (2002). Suicide bombing refers to a type of terrorist tactic where a member of a terrorist organization volunteers for and knowingly faces self-inflicted certain death in detonating an explosive device in order to inflict damage on a target.

[3] The figures are for the period 1981–2007. They include 16,172 deaths and 35,000 injuries (Moghadam 2008: 39).

utility of our cultural resonance framework we make use of the cultural dimensions approach from a branch of organizational sociology (Hofstede 2001) where quantifying culture is well-established. This enables us to assess the role of cultural resonance in a quantitative framework using fine-grained measures of culture. We focus on the adoption of suicide terrorism and a particular cultural dimension: collectivism-individualism. Following this line of work we suggest that persons in collectivist cultures tend to be integrated into cohesive in-groups which results in strong in-group loyalty and rigid between-group boundaries (Hofstede 2001; Hui and Triandis 1985; Triandis 1995). By influencing the actor-utility constitution, the costs of adoption, and the conceivability of the innovation we show how cultural resonance operates in facilitating or constraining the spread of innovations. The case of suicide bombing diffusion, as an extreme innovation involving self-sacrifice, is uniquely suited to vividly illustrate these mechanisms in action.

The Diffusion of Suicide Terrorism

Altruism or the sacrifice of personal resources for the benefit of others has long been an object of scholarly attention (see Piliavin and Charng 1990). But the act of sacrificing *one's very life* for the benefit of a larger cause has posed an especially fascinating problem for sociologists since the birth of the discipline. Emile Durkheim called the type of suicide caused by extreme altruism for the group as "altruistic suicide" (Durkheim [1897] 1989). While Durkheim was primarily referring to suicide that did not involve the deliberate killing of others in the process of killing oneself, his category has arguably foreshadowed the modern phenomenon of suicide bombings, 85 years after the publication of *Le Suicide*.

While most terrorist organizations do not use suicide bombings, the proportion of those

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that do has been rapidly increasing. Indeed in the last couple of decades suicide terrorism has

spread over the globe like a wildfire (see Figure 1). By 1990, 5% of terrorist organizations

deployed this tactic at least once. By 1999 the number rose to 9%. By 2006, 23% of terrorist

organizations used the tactic. Furthermore, not only has there been an increase in the number of

incidents but there has been a drastic increase in the number of organizations and countries

where these groups operate. Until 1994 suicide bombings were conducted in up to three

countries (Lebanon, Sri Lanka, and Israel); in 2005 they were conducted in 15 (Moghadam 2008:

41). From 1981 to 1990 an average of 1.5 organizations conducted attacks per year. From 2001

to 2007 the average was 12.3 per year (Moghadam 2008: 39). Because suicide bombings are

much deadlier than non-suicide attacks (Pape 2005), they have claimed a large share of

casualties and have provoked strong reactions from states both domestically and internationally.
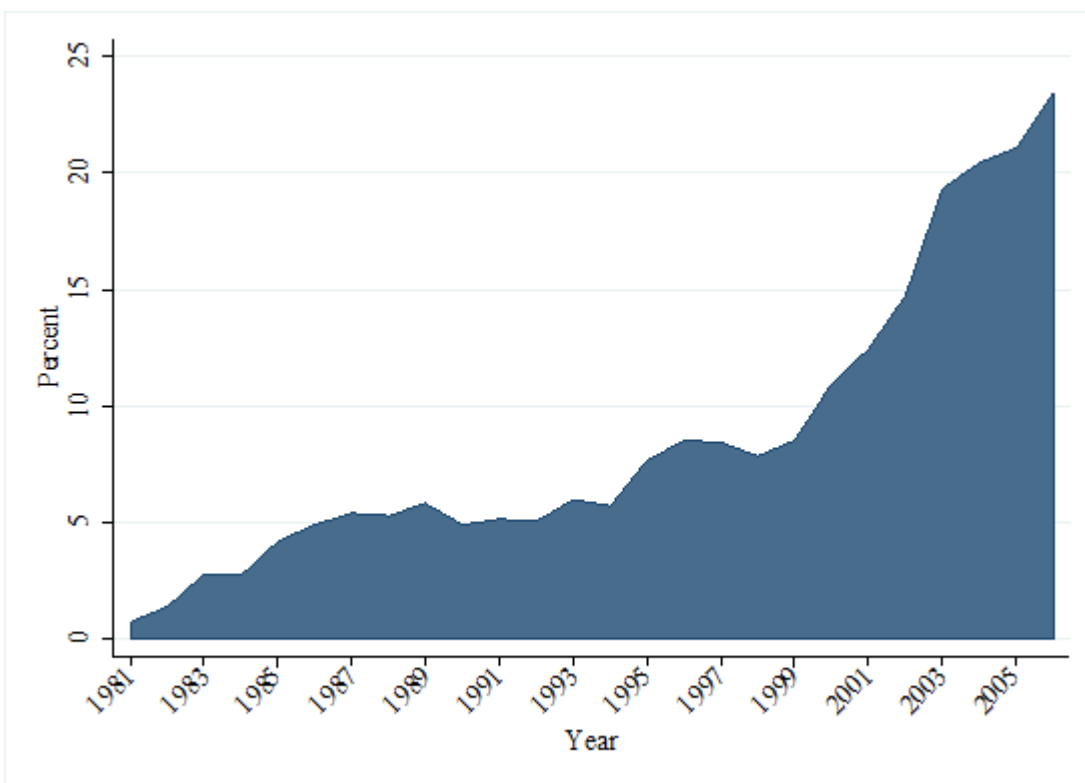

Figure 1. Percent of Terrorist Organizations Active in a Given Year that Adopted Suicide
Bombings, 1981-2006

But in addition to its social effects the tactic of suicide bombing differs from almost every other violent political tactic in that the attacker faces certain death in the process of attacking the adversary. Not surprisingly, the phenomenon of suicide bombings has produced a voluminous literature. Its emergence has been attributed to dissatisfaction with foreign occupation (Pape 2005), hard to reach targets (Berman and Laitin 2005), relative deprivation (Khashan 2003), and intergroup competition (Bloom 2005). Additionally a sizable number of motivational sets have been proposed such as "Nationalistic, community defense, expressive, trauma, revenge, alienation, marginalization, loss of identity, desire for meaningfulness, adventure, secondary traumatization, desire for redemption" (Speckhard 2005:17).

Their differences notwithstanding most such accounts tended to assume that the decision to use this tactic is taken in local isolation without knowledge about its use elsewhere. But as researchers of political sociology have come to recognized that repertoires of contention should not be treated as independent of one another, scholars of suicide terrorism have followed suit. Different social movements (both violent and non-violent) observe, learn from, and influence each other in the kinds of tactics they deploy to realize their goals (Pitcher et al 1978; Holden 1986; Myers 1997, 2000; Soule 1997). Building on this insight, recent work has sought to explain the adoption of suicide terrorism in the context of the tactic's global diffusion. This literature, dominated by political scientists, can be categorized as consisting of three central frameworks, which we term adoption capacity, strategic value, and ideological imperative. But while each one of these approaches sheds light on important aspects of the phenomenon, it also leaves a number of important questions unanswered.

Existing Perspectives on Suicide Terrorism Diffusion and Their Limitations

Adoption capacity explanations of suicide bombings stress the importance of organizational resources such as institutional flexibility. For example older organizations are constrained by inertia and the repertoire of the tactics they are accustomed to using, while newer organizations are more likely to innovate (Horowitz 2010). Ties to other organizations using the tactic also increases adoption (ibid). However, a key insight of the diffusion literature has been that while organizational resources such as network ties may explain the basis of diffusion or *how* the tactic spreads, they do not account for the reasons for *why* one particular innovation spreads and not another (Strang and Soule 1997; Kaufman and Patterson 2005). In other words, it is highly plausible that the tactic of suicide terrorism spread through networks and is adopted by younger organizations but this does not explain why suicide terrorism spreads and not some other tactic. To answer this "why question" scholars focus on one of two distinct logics of adoption: the tactic's strategic value or an adopter's ideological imperative.

Strategic Value accounts argue that the adoption of political tactics is a matter of the tactic's utility in satisfying an organizational goal. Suicide bombings are adopted because they are the best instruments to achieve the terrorist group's goals (Pape 2003). Works in this tradition note that despite its moral repugnance for some actors, suicide bombing is a remarkably versatile weapon. After all suicide bombers are the "poor man's smart bombs" that can inflict massive damage and reach hard targets for a relatively low cost (Hoffman 2008; Berman and Laitin 2005). Democracies are seen as particularly vulnerable since the political costs imposed by the civilian electorate (which bears the brunt of the attacks) on decision makers are especially high (Pape 2003).

Ideological accounts of diffusion highlight the role of belief systems as legitimators of

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tactical decisions. The choice of a tactic that an organization adopts is explicitly influenced by the organization's ideology. The primary element in the logic is duty rather than efficacy. In the context of suicide bombings a large focus of this work is religious ideology arguing that suicide terrorism is ultimately a religious phenomenon. Scholars in this vein claim that other-worldly ideologies make the use of suicide attacks more likely because they promise supernatural rewards in the eternal hereafter in return for individual sacrifice in the finite present (Hoffman 1995; Juergensmeyer 2003; Rapoport 1984). After all, it is not simple to convince a person to give up their very life for a strategic goal; but it becomes a lot easier if eternal salvation is at stake. Scholars in this tradition point to religious justifications expressed by suicide bombers and terrorist organizations who deploy them (Cook and Allison 2007); particularly the language of "martyrdom[4]" or "death in jihad" rather than one articulating strategic value. Furthermore, the highly ritualized way suicide bombings are conducted is further suggestive of the tactic's religious connotation (Atran 2006).

However, while these perspectives remain popular in their respective quarters, a number of empirical studies have challenged both the strategic value as well as the ideological imperative accounts. The data suggests that suicide attacks do not seem to be a strategic response by terrorist groups confronting susceptible democracies and that there is a very wide disparity in the groups that adopt the tactic, despite having the same strategic goals (Piazza 2008). While religious ideology, particularly Islam, seems to play a role in the adoption of suicide bombings for many groups, there is a large variation among the adopting organizations, with many non-

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[4] Islamist terrorists don't view suicide bombings as involving suicide at all; instead the tactic is reframed as a "martyrdom operation" (see Hafez 2006b:176). We ask why is it that such reframing can be done credibly in some cultural contexts but not others. For most of Muslim history "martyrdom" was not associated with suicide, which was forbidden; it meant dying by persecution or more typically in battle for the Muslim faith or even for secular nationalist reasons (Cook 2006).

Muslim, atheist, as well as secular groups also adopting the tactic. Indeed, prior to the Second Gulf War (2003), the Tamil Tigers – a group with a Marxist ideology and with Catholic and Hindu members – was the most prolific user of suicide terrorism (Pape 2005). There are also several secular organizations in Palestine, Kurdistan, and Sri Lanka that deployed suicide missions. Furthermore, not all Islamic organizations use suicide bombings. The ideological imperative account may explain such groups as developing their own non-religious ideology of "martyrdom". However this begs the question of why certain ideologies that legitimate suicide terrorism appeal to some terrorist groups but not others. Moreover claiming that ideological or Islamic movements are more likely to adopt terrorism does not allow one to pinpoint which cultural trait is actually driving this relationship. What is it about an ideology such as Islam or Marxism that makes suicide terrorism so plausible? Is there a common element in such diverse ideologies that transcends the concrete belief system itself? Why don't groups with similar ideologies (Kurdish Marxists but not Italian Marxists) adopt the tactic? Lastly, the adoption of the tactic by religiously-oriented groups has ebbed and waned overtime with a similar trend for non-religious groups See Figure 2. This suggests that there is more to the story than religion.
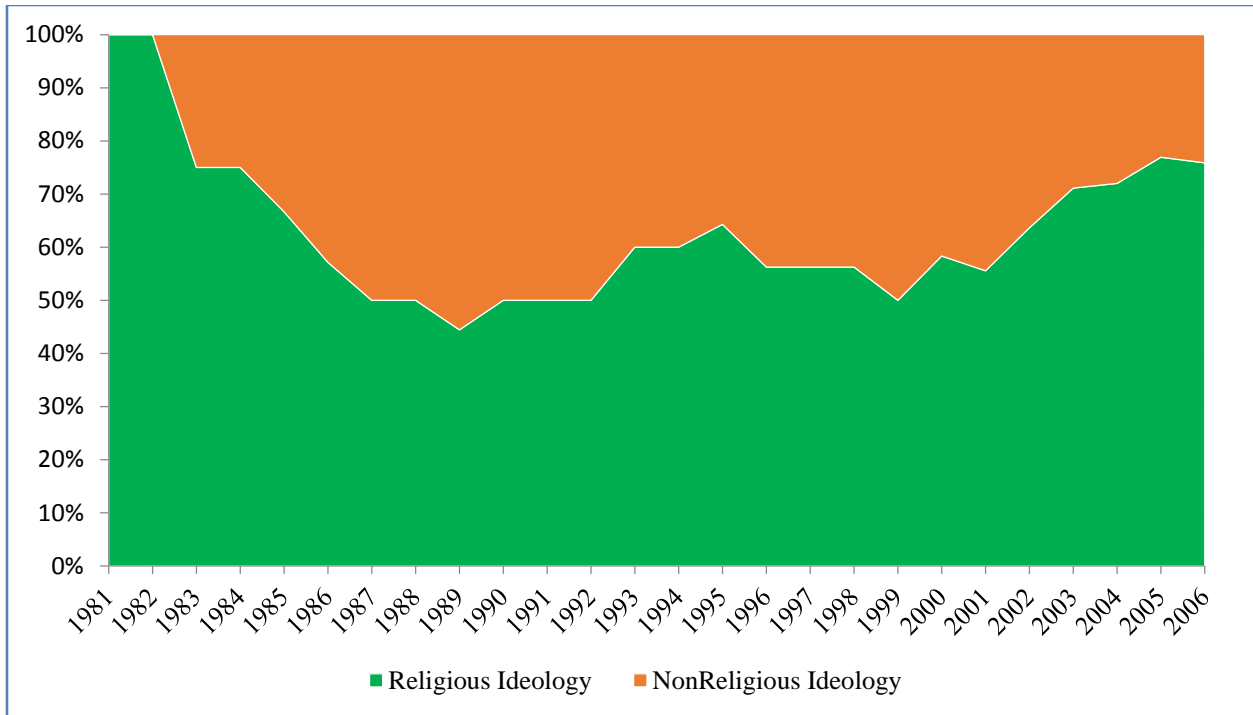
Figure 2: Religious and Non-Religious Terrorist Organizations' Adoption of Suicide Bombing, 1981-2006

The goal of this paper is *not* to decisively refute either account. Indeed we believe there are elements of truth in both. Instead we wish to highlight the deeper cultural dimensions that are relevant to the diffusion process and shed light on some questions that these perspectives leave unanswered. The notion that political groups consider the tactic's effectiveness seems eminently reasonable to us. But the adoption of a practice by an organization is not only a function of the practice's perceived utility. It also has to mesh with the values, beliefs, and attitudes of the members of the wider society in which the organization is embedded. We propose a unique sociologically-informed theory that seeks to better explain a key question behind the phenomenon: why some political organizations adopt this lethal tactic but not others?

Mechanism of Cultural Resonance

The idea that culture affects diffusion is an old one in sociology and dates back to the work of Gabrielle de Tarde (1903). We seek to build on the existing scholarship and articulate the process in a more systematic way. We follow Gert Hofstede in conceptualizing culture as the "collective programming of the mind"[5] that manifests itself in different values, practices, symbols, and rituals. Tarde argued that whether certain social practices get adopted depends on the extent to which these initially foreign elements are consistent with the ideas already in the minds of the adopters (Tarde 1962 [1903]: 245). Innovations, in other words, are more likely to spread to places where congruent ideas are already rooted because newly learned ideas need to fit or resonate with the ideas learned earlier (Eckstein 1988). Rogers makes a similar point when he talks about the compatibility of adoptions (Rogers 1995:15).[6] In trying to achieve our goals we do not adopt strategies haphazardly but are constrained to work from within the cultural toolkit we are familiar with (Swidler 1986). This congruence between the content of the innovation and the cultural makeup of the adopter is what we term *cultural resonance*. We put forward the following proposition in respect to the relationship between cultural resonance and diffusion.

> *Proposition*: The diffusion of an innovation depends (among other things) on the cultural resonance between the innovation and the adopter. Innovations that are culturally resonant are more likely to be adopted than innovations that are not culturally resonant.

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[5] Hofstede emphasizes the cognitive aspect of culture; it is a collectively-shared prism through which its members see themselves and the world. His favorite metaphor, in this respect, is that culture is a type of "software of the mind" (Hofstede1993:1-2). Note that this excludes material aspects of culture.
[6] Also see Herbig and Miller (1991) for an application.

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This relationship obtains for three reasons. First, culture constitutes the very actors who are adopting the innovations, that is, it forms their values, beliefs, and preferences (Katzenstein 1996; Finnemore 1996). Certain innovations are therefore much more likely to be adopted by certain specific actors (but not by others). Second, culture makes certain innovations more *conceivable* than others. As defined above culture entails a cognitive component. It introduces biases into what people see as salient and worth attending to, thereby automatically limiting the range of available choices. Practices that are aligned with deeper cultural values are therefore more likely to be adopted than practices that are not. Third, cultural resonance reduces the costs of innovations. Culture not only limits the number of options available but ranks them as well (Johnston 1998). The more new practices have in common with older practices the less costly it becomes to convince people to engage in these practices. Moreover, resonance reduces the potential societal backlash against innovations. For example it was less costly to introduce sexual contraceptives in a cultural site where there are no ingrained attitudes against birth control (see Wejnert 2002: 313 for other examples).

While distinct, the argument about resonance bears some resemblance to the framing literature in social movement research. Effective social movement entrepreneurs produce frames that resonate with the potential participants and audiences (Snow et al 1996; Benford and Snow 2000; Snow 2004). Frame resonance is the "fit between frames and audiences' previous beliefs, worldviews, and life experiences" (Williams 2004: 105). This kind of resonance is highly individualized in that it is resonance to a specific person's biography. Gamson and Modigliani (1989) have expanded this notion to one's specific country/nation, where the resonance became one's particular cultural narrations and themes such as national myths, folk tales, and symbols. Cultural resonance in this sense refers to elements in each particular culture that social

movements may appeal to. We move a level deeper by explaining why certain social movement frames such as "martyrdom" or "death in jihad" or "it is glorious to die for your people" (in the case of suicide bombing groups) are susceptible to being credible and salient *across many different* countries and cultures and why the resonance exists *in the first place.* Therein lays the unique contribution to diffusion studies specifically, since our framework is able to explain why cultural resonance[7] occurs from one site to another.

The Logic of Collectivist Action

But while the notion that culture influences the adoption of certain innovations is highly plausible, one should be skeptical of ad hoc theorizing that claims that any adoption outcome is a product of cultural resonance. Indeed part of the reason that the role of culture has not received much attention in the diffusion literature is that culture is hard to conceptualize and operationalize in a way that allows for deductive empirical research. To do so, one has to: 1) demonstrate that a coherent culture exists across time and across actors within a society; 2) turn this coherent culture into a tractable, measurable variable; and 3) determine whether this variable systematically influences behavior (Johnston 1998).

The effort to identify underlying cultural orientations that are deeper than the plethora of concrete beliefs, values, attitudes, and ideologies is a relatively new development in the social sciences. Geert Hofstede was one of the first to demonstrate that it is possible to identify cultural dimensions which can be used to compare societies along a common denominator (Hofstede 2001). Hofstede identified five such cultural dimensions: 1) power distance; 2) uncertainty

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[7] While other work uses the term "cultural resonance" in the country/culture-specific sense (Berbrier 1998; Kubal 1998; Williams 2004) we use it in the much broader trans-cultural sense. So while the term is the same, the concept is distinct.

avoidance; 3) long-term—short-term orientation; 4) masculinity—femininity; and 5) collectivism—individualism.[8]

The dimensions were posited by Hofstede after an extensive factor-analysis of a large set of questions administered across many different countries. The instruments were adjusted over time and the questionnaire expanded to more countries. While there are critiques of Hofstede's approach, it has not only survived but flourished over time.[9] Indeed a number of separate/independent research programs have replicated his results and extended the data (see particularly Schwartz 1994, House et al 2004, Inglehart 2010).

This paper considers the collectivism-individualism dimension. We utilize this measure because it is the most validated, the most widely used, and has the most straightforward theoretical link to suicide terrorism. Since the distinction between collectivism and individualism was first proposed, researchers have emphasized different elements of the dimension. But the key element is that collectivist cultures emphasize the interests of groups (e.g. families, tribes, and nations) over the interests of individuals, when those interests conflict. Individualists, on the other hand, emphasize the interests of individual persons. Since the utility of the group is elevated above that of the individual, collectivism legitimates practices that benefit the group, at the expense of the individual. It is noteworthy that the construct is consistent with a key distinction posited by the classical theorists of society; indeed the key researchers in the area readily acknowledge links to Durkheim's organic and mechanical solidarity, Tonnies's Gesellchaft and Gemainschaft, as well as similar distinctions in Western and Eastern philosophy (Hofstede 2001; Oyserman, Coon, and Kemmelmeier 2002; Triandis 2001).

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[8] Two additional dimensions have been very recently proposed, which are Indulgence-Restraint and Monumentalism-Self-Effacement; see Hofstede, Hofstede, and Minkov 2010.
[9] For reviews see Kirkman, Lowe, and Gibson 2006; Oyserman, Coon, and Kemmelmeier 2002; Schimmack, Oishi, and Diener 2005; Sondergaard 1994.
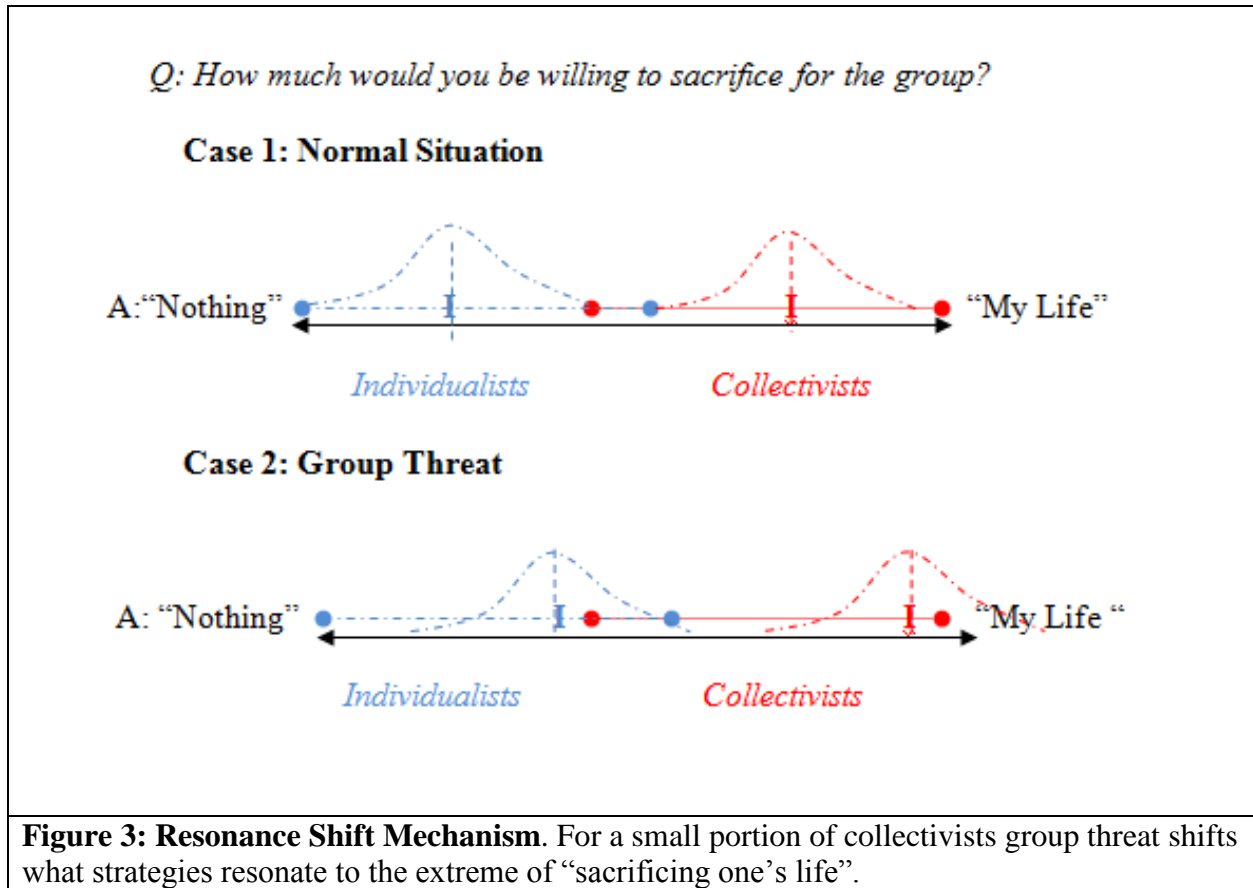
Other researchers have elaborated additional elements. Collectivists tend to view persons in terms of their group membership, place an emphasis on interdependence, group goals, communal relationships, and put primacy on norms in influencing their own social behavior; individualists tend to view persons as individuals and place an emphasis on independence, personal goals, exchange relationships, and put (relatively more) primacy on personal attitudes in influencing their own social behavior (Triandis 2001).

Cultural Resonance in Action: From Collectivism to Suicide Terrorism

Since collectivism is a type of cultural orientation that emphasizes group interests over individual interests and suicide bombing is a tactical innovation that involves the voluntary self-sacrifice of a person on behalf of the larger community, the spread of the tactic offers a useful case study in evaluating the argument of cultural resonance.

Given the theory of cultural resonance we should see this relationship for three reasons. First, collectivism refocuses the very constitution of the actor whose utility is being satisfied: from that of the individual to that of the ingroup. The group-self comes into sharp focus while the individual-self is blurred into the background. Suicide terrorism is an extension of the "sacrifice for the ingroup" logic under extreme circumstances. Situations where members of the collectivist in-group feel that their group is severely threatened may cause some of those persons to contemplate sacrificing themselves, asking fellow in-group members to do the same, and bestowing esteem on those who do. This decision is made palatable because the group is elevated as the primary actor and one feels both the tug of expectations and a sense of responsibility for the group. However, collectivist societies are not filled with persons who have a death wish and individualist societies are not filled with extreme egoists. Under normal circumstances both

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societies value life and contribute to collective goals – albeit to a different extent (Hofstede 1993). Our contention is that only under extreme and desperate circumstances of high in-group threat – a situation that characterizes terrorist groups – that collectivists are pushed further where the prospect of the ultimate sacrifice now resonates for them. See Figure 3.

Figure 3: Resonance Shift Mechanism. For a small portion of collectivists group threat shifts what strategies resonate to the extreme of "sacrificing one's life".

This suggest the following hypothesis.

> *Hypothesis*: Terrorist organizations that are embedded in collectivist cultures will be more likely to adopt suicide terrorism than terrorist organizations embedded in individualist cultures, all else being equal.

Second, valuing the group over the individual lowers costs by reducing societal backlash against self-sacrificial innovations. A key insight about terrorist groups is that they are not modular and almost always require substantial support of a broader population beyond the organizational members. The number of sympathizers is much greater than active members (McCauley 2006) and they closely watch the performance of the organizations that represent their social movement (Bloom 2004). Groups whose leaders miscalculate the support for a tactic decline rapidly. Therefore, decisions by terrorist organizations to adopt costly tactics such as suicide bombings need to be viewed as legitimate by their supporters or sympathizers; and not only by the membership and leadership of the organization. Terrorist organizations embedded in individualist societies that frown on suicide terrorism as a tactic of group defense may have raised costs of adoption even if some of the organization's leadership is favoring its use.

Third, a collectivist society is a society where suicide bombing is more conceivable as an option. It is therefore on the choice menu of the political organization. The opposite is the case for individualist organizations for which suicide bombings are not even contemplated as a tactical option. As we shall see, some individualist organizations view the tactic with such repugnancy that it is considered as simply outside the realm of what is possible.

It is important to note that we are not making a deterministic argument between collectivism and suicide terrorism adoption. Our argument is not about the necessary and sufficient conditions for suicide terrorism diffusion but about the risk of use given certain factors (controlling for other factors). There are some collectivist groups who don't adopt suicide terrorism (though there are no individualists who use the tactic). For example the majority of terrorist Sunni groups in Iraq did not adopt suicide bombings as a tactic. *Our claim is that collectivism presents a condition that makes suicide bombing adoption more resonant.* Of course

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there are other intervening variables in specific cases. Some are case-idiosyncratic and some are systemic.

Next we illustrate the mechanism of cultural resonance in respect to suicide bombing adoption by collectivists but not individualist terrorist groups. We do so by drawing on qualitative, survey, and experimental evidence. We then formally test the hypothesis using an event history analysis framework.

Illustrating the Mechanism: Qualitative, Survey, and Experimental Evidence

While the bulk of our argument rests on a new quantitative analysis, it will be instructive to present some secondary qualitative, survey and experimental evidence of how the mechanism operates. This should not be interpreted as "proof for our case", but as an illustration that provides context for the quantitative analysis and adds plausibility to the theory of cultural resonance. We will illustrate how: (1) suicide terrorists from collectivist organizations emphasize in-group primacy over the individual, as one of the key motivations for volunteering for their missions; 2) on the other hand, individualist groups reject suicide terrorism as a conceivable option; (3) echoes of collectivism are clearly evident not only in the testimonials of the perpetrators, but also in interviews with community members and sympathizers who approve of the tactic's use – showing how cultural acceptance lowers the costs of adoption.

Would-be martyrs frequently describe certain death for one's people or nation in highly positive terms. The key element is the theme of deliberately killing oneself for one's group, not merely "putting one's life on the line". The later discourse is evident in the rhetoric of individualist societies. By contrast, it is the *total certain sacrifice* for one's country or people that is unique for collectivists. Consider the often-quoted will and testament of Muhammad Al-

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Ghoul, a Hamas suicide bomber who killed 19 and injured 52 other Israelis. In it he wrote the following statement to explain his act:

> *How beautiful for the splinters of my bones to be the response that blows up the enemy, not for the love of killing, but so we can live as other people live… We do not sing the songs of death, but recite the hymns of life… We die so that future generations may live (*Hafez 2006a: 90*).*

The Tamil Tigers swear an oath where they commit to sacrifice their life for their land: "I hearby promise that I am prepared to sacrifice my life and fight to create a free Socialist Tamil Eelam, which is the sublime aspiration of our Revolutionary Organization" (Wijesekera 1996: 23). When asked about suicide terrorism and the deadly struggle between the Sinhalese and the Tamils, a boy offered the following sentiment:

> *This is the most supreme sacrifice I can make. The only way we can get our Eelam [homeland] is through arms. That is the only way anybody will listen to us. Even if we die (*Joshi 2000: 64*).*

For this boy the ultimate actor, on whose behalf he is acting, is his in-group rather than himself. Indeed the group is so important that it is worth sacrificing one's life, when it is threatened.

On the other hand terrorist organizations from individualist societies explicitly reject the use of suicide attacks because the tactic is simply *inconceivable* as an option. Kalyvas and Sanchez-Cuenca (2006) cite a letter written by one of the commanders of the Basque ETA group, in response to one of its members volunteering for a suicide operation that would involve killing the King of Spain, which ETA has unsuccessfully tried to do five times. This goal was strategically useful for the organization, but the means suggested were not, as the response letter indicates:

> *With regard to the militant's letter in which he offers himself for more extreme actions (kamikaze-like), we just say that in principle we do not agree with the idea of a militant blowing himself up in a car. Yet, if the militant is willing to run a high risk, there could be a chance to carry out an action following a funeral* (Kalyvas and Sanchez-Cuenca 2006: 212).

The letter then proceeds to offer an alternative operation to a suicide bombing that is very high-risk[10] but which does not involve certain death (ibid). Kalyvas and Sanchez-Cuenca cite an expert who describes ETA's behavior as follows: "The rule has been to act under maximum personal security and, when in doubt, not to act" (ibid). We see that the life of individual members is clearly valued vis-à-vis the organization's goals.

Finally, collectivism lowers the cost of adoption of a prima facie costly tactic that involves the certain death of members. A critical part of our argument is that the tactic not only resonates with the member of the terrorist group but with the sympathizers who support it. As previously mentioned, terrorist organizations are embedded in a deep web of connections beyond their immediate members. The use of risky tactics depends, in large part, upon the approval of their sympathizers. For example the Armenian Secret Army for the Liberation of Armenia (ASALA) and the Egyptian Islamic Group (EIG) were abandoned by supporters after ASALA's 1983 bombing of a Turkish airliner in Paris killing 8 and wounding 55 and EIG's bombing of the Luxor temple, killing 58 tourists and wounding 20 (McCauley 2006). Collectivists grant approval, esteem, and status to individuals who give up their lives in a suicide mission on behalf of the community; individualists withhold such status. This substantially lowers the cost of the tactic and increases the likelihood of adoption.

As further evidence of collectivist publics supporting suicide missions we conducted a preliminary analysis by looking at the data collected by the Pew Global Attitudes Project (Pew 2010). From 2002-2010 Pew asked Muslim respondents in 25 countries whether suicide attacks

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[10] It is also important to keep in mind that there is a subjective transformation of risk that may take place; what is high-risk to the neutral observer may actually be perceived as modest risk by the organization or the participant. Psychologically they may (wishfully) think that they will be the "lucky ones" to escape. This transformation is simply not possible with operations that involve certain death, since there is no hope of surviving – indeed surviving is not the goal. There is, therefore a qualitative difference between the perpetrators believing the risk of death is 99% vs 100%.

against civilians were [sometimes, never, or often] justified. The percent of Muslim respondents who answer that the attacks are sometimes or often justified varies from year to year and from country to country. We correlated the country collectivism scores with the percent of the population that supported suicide missions. While almost all the countries scored above the median on collectivism, an implication of our argument is that more collectivist countries should have a higher percentage of their populations endorse suicide bombings than those who score lower. This was supported as the average correlation between collectivism level and suicide bombing support was 0.36.

Additionally, there is consistent experimental evidence that collectivists endorse various kinds of sacrifice for the group and do so behaviorally in various social dilemmas games (Chen, Chen and Meindl 1998; Cox, Lobel, and McLeod 1991; Wong and Hong 2005.). Agreement with statements such as "People in a group should be willing to make sacrifices for the sake of the group's well-being" was strongly correlated with scoring high on collectivism (Wagner 1995: 162). One study found that Vietnamese subjects playing a prisoners dilemma game were willing to persist in cooperating even against an all-defect (100% competition) opponent (Parks and Vu 1994).

There is also growing evidence regarding collectivism as it relates to terrorism specifically.[11] Kruglanski et al (2009) report that respondents from 12 Arab countries as well as Pakistan and Indonesia who subscribed to collectivist goals were more likely to support attacks on American civilians than those who subscribed to individualist goals. Argo (2004) conducted a survey on a sample of 351 Palestinians living in the Balata Refugee Camp and examined whether Schwartz's communal and self-enhancement values (which parallel collectivism and

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[11] See Weinberg and Eubank (1994) for a study of collectivism and non-suicide terrorism.

individualism (Schwartz 1994) predict the type of resistance activity the respondent would endorse. The anchors ranged from making almost no sacrifice - visiting an injured person in a hospital, to making some sacrifice – joining a rally during a curfew, to making a large sacrifice – conducting a suicide attack. She finds that persons with communal values are far more likely to endorse high risk or high sacrifice resistance than persons with self-enhancement values.

However, while this body of work gives considerable plausibility to the notion that collectivist culture can stimulate the adoption of sacrificial strategies by shifting actor focus, making a tactic a conceivable option, and lowering the cost of its adoption, it does not demonstrate that the diffusion of suicide terrorism is actually driven by deeper cultural processes. The qualitative evidence we presented is scattered, anecdotal or does not consider negative cases in a systematic fashion. Moreover, it does not control for other domestic and international factors such as organizational age (Horowitz 2010), group resources (Asal and Rethemeyer 2008), or grievances (Gurr 2000) that might explain away the observed relationship between collectivism and the adoption of suicide terrorism. Moreover, survey evidence looks largely at attitudes that do not necessarily predict behavior (Glasman and Albarracín 2006; Gross and Niman 1975; Schuman and Johnson 1976).

Therefore, we now turn to a quantitative test of the hypothesis that collectivism increases the probability of suicide terrorism adoption, employing both adopting and non-adopting cases to avoid sampling on the dependent variable and controlling for other factors that may provide alternative explanations.

Data and Methods

Dependent variable

　　To systematically assess our hypothesis we analyze the first adoption of suicide terrorism

by 415 terrorist organizations. We select terrorist organizations as our unit of our analysis, as

opposed to countries (Wade and Reiter 2007) or attack events (Piazza 2008) because the

analytical focus of this paper is tactical adoption, which is done at the organizational level

(Horowitz 2010).[12] We rely on two sources to identify terrorist organizations. First, we make use

of the RAND incident database (Jones and Libicki 2008). This database lists all non-state

organizations that conducted violent attacks between 1968 and 2001. For each organization, it

reports the location of the group's home base, size, ideology, as well as the founding and

dissolution dates. Based on the Terrorism Organizational Profiles database (TOPS 2010) we

independently confirmed the existence of each of the organizations, removed doublers (aliases,

covers, etc.) and added a couple of organizations that were missing from the original RAND file.

This resulted in a total of 600 organizations. From this list we deleted all organizations that

ended before 1981, since this was the date of the first modern suicide attack (Moghadam 2009;

Pape 2004; Pedahzur 2006). In addition we removed all organizations that existed for less than a

year and conducted less than one attack.[13] Of the 415 remaining organizations, 68 conducted

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[12] However, we also conducted analysis in which events, countries and cultural groups were the unit of analysis. In
all three cases we found a significant positive effect of collectivism on suicide terrorism. In an additional analysis
we also controlled for general terrorist activity (by modeling the number of attacks an organization conducted per
year), to address the concern that collectivist organizations are more active users of terrorist tactics in general. The
results of this analysis were congruent with those presented in Table 2.

[13] This was done because our unit of inference is the terrorist group and we are particularly interested in relatively
durable organizations. Including groups that existed for less than a year picks up anomalous entities such as the
Internet Black Tigers (a group that engaged in a cyber-terrorist attack on behalf of the LTTE), eclectic entities such
as the Vitalunismo (a "group" comprised of one person whose ideology is connected to UFO conspiracies) or groups
that may have been temporary shills of state intelligence agencies to conduct operations with plausible deniability
such as Counterrevolutionary Solidarity (a right-wing Guatemalan group that conducted a single bloodless attack
against a Sandinista ambassador).

suicide attacks. Please see Appendix A for the groups used in the analysis as well as their collectivism score.

The analysis begins in 1981 after the first suicide attack against the Iraqi embassy in Beirut and ends in 2006, the last year for which data is available. Data on the exact timing of adoption is obtained from four different sources: 1) Chicago Project on Suicide Terrorism (Pape 2003); 2) Terrorists, Insurgencies, & Guerillas in Education and Research (Pedahzur 2010); 3) World Wide Incidents Tracking System (WITS 2010); and 4) Global Terrorism Database (GTD 2010). Each of these datasets identifies the exact date and the organization responsible for the attack. Based on this information we were able to link attacks to the 415 organizations. We did this in two steps. First, we retrieved aliases of all the organizations in our sample from the TOPs database. Second, these aliases and main names were used to link attacks to specific organizations. Since we are interested in the diffusion of suicide terrorism, we only looked at the date of first adoption. After an organization adopted suicide terrorism it left the analysis because it was no longer "at risk" of adopting suicide terrorism.

An event counts as a suicide bombing if the perpetrator's act is meant to kill or maim others through the use of an explosive device and where the 1) bomber volunteers and 2) knowingly faces self-inflicted certain death in detonating the explosive device. The dataset thus excludes cases where the detonation was done without the knowledge of the bomber, or through coercion or deception. We include cases of attacks that were in the process of being carried out but were "unsuccessful" for some reason (e.g. detonation mechanism failed, the bomber was intercepted, the bombers changed their mind, the bomber detonated but the would-be victims were unharmed).

Independent variable

There are a number of scales that measured and collected data on collectivism-individualism at the ethnic and national-group level. However, instead of using a particular scale, we constructed a single index out of multiple scales. We did this for three reasons. First, since each scale uses slightly different groups, we wanted to minimize the amount of missing data and imputation in our analysis. Second, since the scales measure collectivism and individualism in slightly different ways, but are otherwise correlated; it would make the analysis far more robust. Third, because each scale suffers from somewhat different shortcomings, using a composite measure would balance out the problems associated with any single scale. We built an index out of four well-known and extensively validated instruments that measure collectivism: Hofstede scale (Hofstede 2001), Trompenaars scale (Trompenaars and Hampden-Turner 1998), Globes scale (House et al 2004), Schwartz's scale of embeddedness (Schwartz 1994), and the Survival/self-expression scale developed by Inglehart (Inglehart 2010).

All these measures provide information on collectivism on either the national or ethnic group level. Since the measures are scaled differently, standardized scores were used to construct the index. The resulting collectivism/individualism index is reliable ($\alpha=0.81$). The scores ranged from -2 to 2, with the anchor points denoting the most individualistic and the most collectivistic groups respectively. For more information on the scale, please see Appendix C.

The final scale provided information on 60 ethnic groups representing 336 organizations. However this still left 32 countries or ethnic groups to be imputed since their scores were not listed in any dataset. The imputations represented 79 cases (out of 415 or about 20% of the cases). Some studies that used Hofstede's data imputed missing values by taking the geographic regional mean scores (Scherer 1997). However, one has to be careful in inferring cultural

characteristics of terrorist groups from their nations. Some terrorist groups don't accept the

national culture of the state they are fighting, some have been recently occupied, and some are

composed of immigrants from another culture. We therefore opted for a somewhat less crude

approach. Terrorist groups that needed to be imputed were divided into two groups: ethno-

nationalist groups and national groups. The former included ethnic/cultural groups who were

clearly different from the host country/territory in which they conducted attacks (e.g. Palestinian

Islamic Jihad in Israel, Arab cells in Europe, Tamils in Sri Lanka, Muslim Kashmiris in India,

Chechens in Russia). Imputation was done in the following manner. The base of the group's

operations was taken as the foci. Next a geographic neighbor was identified that had data

available, spoke the same language, and adhered to the same religion. For example the Tamils in

Sri Lanka were assigned India's scores; Kashmiri's of India were assigned Pakistan's scores,

Palestinians in Israel were assigned Jordan's scores. *If there was doubt, the more conservative*

scores were assigned that would favor the null hypothesis. For more information on the

imputation procedure, please see Appendix B. Data on language and religion was obtained from

Fearon (2003) and Fox (2004) respectively.

The nationalist-group category included groups that shared a culture with the host

country in which the attacks were launched; they typically included groups that were fighting for

social revolutionary change, for a religious revolution, or as right-wing groups seeking to

preserve the status quo (e.g. Andres Castro United Front, Yemen Islamic Jihad, Recontra 380).

Those groups received the score of the host country or of the geographic neighbor that had data

available and which was culturally closest to the country. Transnational groups (e.g. Cambodian

Freedom Fighters, Al Qaeda, Free South Moluccan Youth) were given the scores of the

originating country. To make sure that our analysis was not biased by our imputations we present

models with and without the imputed scores.

It is important to note that we are estimating terrorist organization-level collectivism scores from country-level collectivism scores, based on the countries and ethnic groups to which the terrorist members belong. Let us briefly explain the justification for such an inference. It is likely that members selected into terrorist organizations are more collectivist on average than members of their societies. Furthermore some have argued that terrorist groups tend to reinforce collectivism (Post 2005; Post, Sprinzak, and Denny 2003; Schwartz, Dunkel, and Waterman 2009). In this sense we are offering a conservative test biased in favor of individualism and the null hypothesis. Moreover, as Hofstede (2001) points out, cultures are holistic and interconnected entities and while their members may differ in their particular level of collectivism, they are influenced by the overall level of collectivism of the society they are embedded in.

Second, as previously mentioned, the mechanism by which collectivism works is not centered on the terrorist group exclusively. A substantial portion of society in which the terrorist group is embedded has to support the martyrdom of its members. They have to assign positive status to those who sacrifice and they have to approve of suicide operations, which are done on their behalf. Country-level collectivism scores help capture this broader group. Finally, while for obvious reasons it is almost impossible to measure terrorist organizations directly (at the group level) an important finding in the collectivism literature lends some confidence that our inference is correct. While there is variation in collectivism within societies, there is much greater variation between societies (House et al. 2003)[14]. It is highly likely that if we actually measure the collectivism level of, for example, members of the Irish Republican Army and those of

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[14] Similar point is made by Inglehart and Baker (2000) regarding basic cultural values.

Hezbollah, the actual scores will be somewhat more collectivist than that of Ireland (0.39) and that of Lebanese Shiites (-0.19) respectively; but the scores will still be close to their respective countries of origin and in the very least they will preserve their ordinal ranking. So while we may be underestimating the true level of collectivism, this bias is similar for all our cases. Therefore there is little reason to believe that the relationship between collectivism and adoption would change if we somehow managed to collect and examine organizational level data.

Control variables

In order to make sure that the relationship between collectivism and the adoption of suicide terrorism is not spurious, we control for several additional variables. In particular we consider alternative organizational level variables such as ideology, age, size, and the presence of competitor organizations that other researchers identify as influential in the spread of suicide terrorism. We also examine contextual variables such as a country's GDP and regime type which are likely to correlate with collectivism. Finally we consider spatial autocorrelation and network effects as alternative explanations that may make the collectivism effect spurious. The variables and their selection rationale are discussed in detail below.

Religious ideology: A number of scholars argue that suicide terrorism is first and foremost a religious phenomenon, claiming that otherworldly ideologies in general (Kushner 1996; Weinstein, Porter, and Eizenstat 2004) and Islam in particular (Baruch 2003; Kanazawa 2007) make the use of suicide attacks more likely because they promise supernatural rewards for individual sacrifice. Others suggest that it is religious differences between groups that spark the deployment of suicide terrorism (Juergensmeyer 2003). Moreover, scholars of cultural dimensions find that religiously-based cultures tend to be more collectivist (Hofstede 2001;

Inglehart 1995). We therefore included dummy variables for groups that explicitly organized around any religious ideology as well as Islamic ideology in particular (TOPS 2010; Jones and Libicki 2008).

Nationalist ideology: A similar argument can be made about groups motivated by ethnonationalism. Nationalist ideology emphasizes strong in-group attachment and helps society solve certain kinds of collective action problems such as self-defence. Nationalism can be effective in encouraging greater commitment and may mobilize sacrificial behaviour for the group (Reiter 2007; Stern 1995). Pape (2003) argues that suicide terrorism is an effective strategy to expel occupiers out of land one considers rightfully one's own. Since nationalism is more frequent in collectivist countries we control for nationalism by adding a dummy variable that marks all groups that are motivated by nationalist sentiments (as coded by TOPS 2010; Jones and Libicki 2008).[15]

Organizational Age: Institutionalist-oriented scholarship suggests that younger terrorist groups are more likely to adopt innovative tactics such as suicide terrorism, whereas older organizations stick to the "tried and true" strategies that were around when they were first founded. Horowitz (2010) makes this argument by focusing on the wave of suicide attacks conducted by newly formed groups in Iraq and Afghanistan. Since these groups also tend to be collectivist we control for the age of terrorist groups. The age measure is obtained by subtracting the year of birth from the year of analysis.

Organizational Size: It is also plausible that groups with large resources are faster adopters than groups with few resources. Smaller groups may simply not afford to spare members for missions that involve certain death (Asal and Rehthemeyer 2008). Both the RAND and the TOPs datasets

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[15] We also controlled for other ideologies such as left-wing, right-wing, and revolutionary but do not include them in the model because they had no effect.

provide information on approximate group size, which is a reasonable proxy for group resources. For each organization it is reported whether it has 0-10 members, 10-100 members, 100-1,000 member, or more than a 1,000 members. We include dummies that mark organizations of different sizes.

Organizational Density: A prominent line of research on suicide terrorism explains the phenomenon by the intense competition between terrorist groups over constituents for the title of "the one true representative" of a cause (Bloom 2004; Hafez 2006b). Due to the extreme nature of suicide bombings as a tactic, groups who adopt it display authentic commitment to the cause. This in turn allows them to win a greater "market share" of the hearts and minds of their local populations. According to this logic some terrorist groups are forced to adopt the tactic to simply stay competitive with their suicide-bombing using rivals. We therefore control for inter-group competition. Following Piazza (2008) we operationalize this variable as a simple count of the terrorist groups that are active in a country and share the same constituent population.

Regime Type: As described earlier, a version of the Strategic Value account of suicide terrorism argues that democracies should experience more attacks since these regimes are not able to absorb large civilian casualties (Pape 2003)[16]. Moreover there is a strong correlation between democracy and individualism (Hofstede 2001), which may explain away the relationship between collectivism and the adoption of suicide terrorism. Therefore we include a dummy that marks all groups active in democracies. Polity scores are used to classify regimes; a country with a Polity score of 6 or higher is considered a democracy (Jaggers and Gurr 1995).

GDP: It is often asserted that poor countries are likely to suffer from more suicide terrorism than rich countries since it is easier for terrorist groups to recruit self-sacrificial individuals when

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[16] Piazza (2008) however finds that the opposite is true. He argues that this can be explained by the fact that there is a strong negative relationship between democracy and political violence in general.

economic conditions in a country are dire and people are more desperate (Pedahzur, Perliger, and Weinberg 2003; Schbley 2000). However, a number of studies have seriously questioned this relationship (Krueger and Maleckova 2003; Sageman 2004; Piazza 2006); But while the effect of poverty on suicide terrorism may be contested, it is important to control for it, since collectivism is strongly correlated with economic development (Hofstede 2001) and this correlation might actually affect the statistical association between collectivism and the adoption of suicide terrorism. We use logged GDP per capita as a proxy for economic prosperity of a country. GDP numbers were evenly divided by 1000 to reduce the number of digits. Data is obtained from the Penn World Table (Summers and Heston 1991).

Prior Adoptions in the Region: It has been demonstrated that cultural traits are concentrated in space (Scherer 1997). The adoption of suicide terrorism is also geographically clustered because prior use of the tactic by proximate actors may inspire their neighbors to do likewise (Hedström 1994; Myers 2000). Therefore it is possible that the statistical relationship between the adoption of suicide terrorism and collectivism is biased by spatial autocorrelation (Ward and Gleditsch 2006). We handle this problem by modeling former counts of geographically proximate adoptions. We calculated minimum distances between terrorist organizations in the following way. For minority groups we obtained geographical locations from the GREG-dataset (Weidmann, Rød, and Cederman 2010). For non-minority groups we assumed that they were active throughout the entire country in which they were based and used the geographical information of these countries, which was retrieved from the C-Shapes dataset. We experimented with different types of spatial neighborhoods. The analysis suggested that the effect of the parameter became stronger up to 500 kilometers after which it experienced a distinct drop-off.

Therefore we decided to model the number of prior adoptions within a 500 kilometer radius.[17]

Organizational Ties: Perhaps the relationship between collectivism and suicide terrorism is spurious for yet another reason. Perhaps terrorist organizations that use suicide bombings are more likely to have ties to other terrorist organizations that they influence to adopt the tactic. It is well known that similar cultural groups are more likely to form ties with each other. Therefore, it could be that collectivist terrorist groups are more likely to form ties with one another but the use of suicide terrorism has nothing to do with them being collectivist but with the fact that some of them happened to have been earlier adopters and were able to cascade the practice within their networks. To test this possibility we used a dataset from Horowitz (2010) that has a variable which lists a given terrorist organization's ties to other organizations that use suicide terrorism. Since this variable is only available for some organizations in our dataset and does not vary over time we estimate a separate model for it.

Method of analysis

We use an event history model to analyze the data described above. Event history analysis allows us to focus on the duration between events in countries. This type of analysis is preferred over time series designs of aggregate data because it enables us to exploit all available information on the exact dates of violent events (Olzak 1989). Moreover, event history models have proven to be very successful in simultaneously explaining where incidents happen and how they diffuse from one place to another (Strang and Tuma 1993). For each duration period, event history models estimate the transition rate from one state to another; in our case the event is the adoption of suicide terrorism. This transition rate is better known as the hazard rate and is

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[17] We also modeled all prior adoptions conditioned on inversed geographical distance (Hedström 1994; Myers 2000). Results were consistent with the ones presented in Table 2.

denoted as λ. Formally λ is:

$$1) \quad \lambda(t) = \frac{P(t \leq T < t + \Delta t | t \leq T)}{\Delta t} \ ,$$

Where T is the exact time of the event, the hazard rate is a function of the probability that an event happens between t and t + Δt, given the fact that it did not happen at time t. In our case it is the probability that a given duration ends in a suicide attack between t and t + Δt for a group in which no adoption occurred at time t. This focus on durations enables us to investigate how time-varying and time constant characteristics of terrorist groups affect the transition rate – the adoption of suicide terrorism as a tactic (Blossfeld and Rohwer 2002).

Event history modeling has also proven to be very successful in simultaneously explaining where incidents happen and how they diffuse from one location to another. That is because the event history approach offers tools to deal with time dependence – overtime fluctuations in the dependent variable that are not captured by the included covariates (Strang and Tuma 1993). For example, international system shocks such as the 9/11 attacks and insurgencies in Iraq and Afghanistan are likely to have an impact on the adoption of suicide terrorism. But it is almost impossible to parameterize all processes which might potentially affect the estimates in our model. This raises a major analytic problem. Apparent diffusion effects might not be caused by inter-actor imitation but instead follow out of simultaneous adaptations to environmental changes. Or to paraphrase Max Weber: the fact that people open their umbrellas when it starts raining is due to the rain rather than to mutual imitation (Weber 1968 [1922]: 23).

Figure 1 shows that the adoption of suicide terrorism leveled off initially before it started to increase rapidly. This suggests that the adoption rate is indeed affected by overtime changes in

the environment. In an event history framework this problem can be dealt with by using partial

likelihood techniques developed by Cox (Cox and Oaks 1984).[18] Once assumptions are met,

partial likelihood techniques estimate coefficients that are constant for the entire time period.[19] In

this way overtime fluctuations in violence are accounted for, making cross-sectional and

diffusion effects more robust.[20]

Partial Likelihood estimation of coefficients is captured by the hazard function of the

Cox-Regression, which is denoted below:

$$2) \; \lambda_i(t) = \lambda_0(t) e^{\beta_1 X_1 + \beta_2 X_2 \dots + \beta_k X_k},$$

where $\lambda_0 (t)$ is a general hazard function that is equal for all countries in the data. This function

is called the baseline hazard and remains unspecified. One could consider it as the shape of the

hazard function for a country which scores zero on all covariates. The latter part of the equation

consists of a set of covariates which is exponentiated to ensure that it does not become negative.

The coefficients generated in a Cox regression, e^{β} in the formula above, should be interpreted

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[18] The event history framework also allows one to model overtime changes in the hazard rate with continuous distributions such as the Weibull, Gompertz, normal, log-normal, log-logistic or gamma distributions. Although these approaches are more efficient than the one chosen in this paper, they do not provide satisfactory models for survival times in all circumstances (Cox & Oakes: 1984). None of these distributions fit the adoption rates studied in this paper very well. However, we also estimated models which followed these distributions. Again, results were consistent with those presented in Table 2.

[19] The model assumes that variables included in the model shift the baseline hazard multiplicatively and that these shifts are constant over time: the proportional hazards assumption. This assumption can be tested by means of a Schoenfeld residual test. Schoenfeld residuals can be retrieved for each covariate by calculating the difference between the covariate value for a failed observation and the mean covariate value of all subjects at risk when the failure took place. Accordingly, one has to fit a function of time and test whether there is a relationship. If the slope of the time effect does not significantly differ from zero, the proportional hazards assumption is met (Cleves, Gould, and Gutierrez 2008). Inspection of the Schoenfeld residuals indeed indicated that the proportional hazard assumption of the models was not violated.

[20] We also estimated a rare event logistic regression (King and Zeng 2001) for group-year combinations of groups that had not yet experienced an event. Results were consistent with those presented in Table 2. We also experimented with different adoption thresholds and also modeled the number of attacks that each organization conducted after adopting. All results were in line with what is presented in Table 2.

as hazard ratios, i.e. the amount by which the baseline hazard is multiplied for each one point increase in the related dependent variable (Blossfeld and Rohwer 2002).

The analysis begins in 1981 and ends in 2006. In total 415 durations are analyzed, one for each organization. Not all organizations existed for the entire time period. An organization entered the analysis at its date of birth and left the analysis for one of three reasons. First, it adopted suicide terrorism and was henceforth no longer at risk of adopting. Second, it dissolved before it had a chance to adopt suicide terrorism. Third, the group had not adopted by the time the analysis period was concluded. Out of all the terrorist organizations, 68 adopted suicide terrorism before 2006 and 347 were right censored, i.e. they ended because they dissolved or because the analysis period was over. In four cases problems emerged with groups that adopted in either their year of birth or in 1981. Event history analysis cannot handle durations of zero. We resolved this problem by adding a small number (.000001) to the time of adoption (Cleves, Gould, and Gutierrez 2008).

Another methodological concern in the present analysis involves unobserved heterogeneity. Several terrorist organizations in this study are active in the same country. Countries share a lot of characteristics that are likely to mitigate or accelerate the adoption of suicide terrorism. Organizations are therefore not entirely independent of each other. This violates one of the basic assumptions of regression analysis and is likely to introduce a downward bias in standard errors. A heterogeneity test indeed suggests that organizations in the same country share unobserved characteristics. We handled this problem by estimating standard errors without assuming that organizations active in the same country are independent.[21] This makes our standard errors robust to violations of the independence assumption.

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[21] We made use of the cluster option in Stata 9.

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Results

Table 1 depicts a first cut at our data. It shows the adoption of suicide terrorism broken

down by collectivism. Of all organizations that score high on the collectivism scale,

operationalized as having a median score or higher, more than a quarter adopt suicide bombing

as a strategy. On the other hand, only 7 percent of all terrorist organizations that score low on the

collectivism scale deploy suicide attacks. Therefore the table strongly suggests that collectivist

groups are more likely to adopt suicide terrorism. Next we examine whether this relationship

also holds once we control for possible confounding factors.

Table 1. Adoption of Suicide Bombings Based on the Organization's
Collectivism Level, 1981–2006

Collectivism	N	Percentage of Adopters
High (above or equal to the median):	215	25.1%
Low (below the median):	200	7%
Total:	415	16.4%

Table 2 presents the results of the partial likelihood regression of suicide terrorism

adoption by 415 terrorist groups, while controlling for other variables.[22] The coefficients

represent hazard ratios, i.e. the increase in hazard for each one point increase on the relevant

variable. The models confirm our hypothesis; collectivist groups are more likely to adopt suicide

terrorism, controlling for alternative explanations. A one point increase on the collectivism scale,

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[22] We re-estimated every model without influential observations. Again, results were consistent with those presented in Table 2.

which runs from -2 to 2, increases the adoption rate by almost 2800 percent. This effect holds even if we control for nationalist, religious (Model 1) or Islamist (Model 2) ideologies. It suggests that collectivism accelerates the adoption of terrorism independently of other cultural factors. Models 3 and 4 further show that this result is not driven by our imputation method. If we re-estimate the model without the imputed cases we still find a positive and significant relationship between collectivism and the adoption of suicide terrorism. In fact the relationship actually becomes a bit stronger.

When we consider the control variables we find that religious groups are much faster adopters of suicide terrorism than non-religious groups. Indeed the adoption rate of religious groups is almost six times higher. Islamist groups are especially likely to adopt suicide terrorism having an adoption rate that is 6.5 times higher than non-Islamist groups. We find no effect of nationalist ideology. Consistent with the findings by Horowitz (2010) we find a negative relationship between age and the adoption of suicide terrorism. However the coefficient is not significant.

The size of the group does appear to play a role. The gradual increase in the coefficient of the three dummies suggests that there is a linear relationship between size and adoption: the bigger the group the faster it adopts suicide terrorism. This suggests that groups with greater resources are better able to recruit human bombs and is consistent with the observation made by Asal and Rethemeyer (2008) that large terrorist organizations can be more lethal and destructive.

Confirming the competition argument (Bloom 2005) we find that suicide bombings are more likely to be adopted in regions that experience intense competition between terrorist groups over the same constituents. Each extra competitor increases the adoption rate by five percent. The country-level variables also have some noteworthy findings. In contrast to claims advanced

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by Pape (2003), regime type does not appear to affect the adoption of suicide terrorism and democratic regimes do not seem to experience more suicide attacks. This is consistent with a similar analysis by Pape's subsequent critics (see Wade and Reiter 2007). We also do not find a relationship between GDP and suicide terrorism.

Model 5 addresses the role of ties to suicide bombing organizations. We would like to point out that the terrorist group ties data compiled by Horowitz (2010) relies on a relatively smaller number of terrorist groups and hence the number of organizations in the analysis dropped to 89. Each extra tie to an organization that uses suicide terrorism increases one's own likelihood of adoption by 1.5%. We find that the effect of collectivism does not disappear but becomes stronger. This confirms our argument that while other factors play an important role in the diffusion of suicide bombings, they are not the full story.

Table 2. Partial Likelihood Regression Models of Suicide Terrorism Adoption, 1981–2006

	Model 1 (Imp)	Model 2 (Imp)	Model 3 (~Imp)	Model 4 (~Imp)	Model 5 (Imp)
Collectivism	2.834**	2.407**	3.607**	2.712**	7.763**
	(1.039)	(0.802)	(1.537)	(1.050)	(3.655)
Religious	5.273**		9.473**		
	(2.118)		(5.246)		
Islamic		6.508**		13.034**	16.720**
		(3.015)		(8.473)	(8.700)
Nationalist	1.190	1.204	1.633	1.810	1.119
	(0.414)	(0.411)	(0.928)	(1.060)	(0.730)
Age	0.997	0.997	1.003	1.003	0.984
	(0.008)	(0.008)	(0.012)	(0.012)	(0.029)
Size 10-100	2.331**	2.143**	3.900**	3.300**	5.372**
	(0.669)	(0.593)	(1.039)	(0.823)	(3.064)
Size 100-1000	3.630**	3.420**	2.487*	2.072	10.478**
	(1.272)	(1.216)	(1.058)	(0.972)	(6.621)
Size >1000	3.760**	3.968**	2.961*	2.992*	0.691
	(1.822)	(1.908)	(1.629)	(1.505)	(0.623)
Organizational Density	1.049*	1.050*	1.074**	1.072**	1.144**
	(0.024)	(0.024)	(0.023)	(0.022)	(0.044)
Democracy	0.628	0.661	0.617	0.688	2.435
	(0.192)	(0.195)	(0.153)	(0.183)	(1.313)
GDP (logged)	1.999*	2.077*	2.481**	2.535**	3.703
	(0.640)	(0.698)	(0.561)	(0.564)	(2.952)
Prior adoptions	1.140**	1.134**	1.154**	1.144**	0.937
	(0.037)	(0.037)	(0.040)	(0.038)	(0.055)
SBO Ties					1.528*
					(0.286)
Spells	415	415	336	336	89
Failures	68	68	49	49	25
Log pseudo-likelihood	-297.225	-294.705	-192.782	-190.187	-51.418

Note: Coefficients represent hazard ratios. Robust standard errors are clustered by country and are indicated in parentheses.

*p < .05; **p<.01 (two-tailed tests).

Because it is somewhat counterintuitive to interpret the magnitude of hazard ratios, we also compute predicted probabilities (Cleves, Gould, and Gutierrez 2008). We estimate the probabilities for quartiles scores on the collectivism scale after setting all control variables in Model 1 to their median. Results are presented in Figure 4 below. At the end of our analysis period, the probability of having adopted suicide terrorism is around 11% for groups that score low on the collectivism scale (i.e. more individualist) and almost 60% for groups that score high on the scale[23].
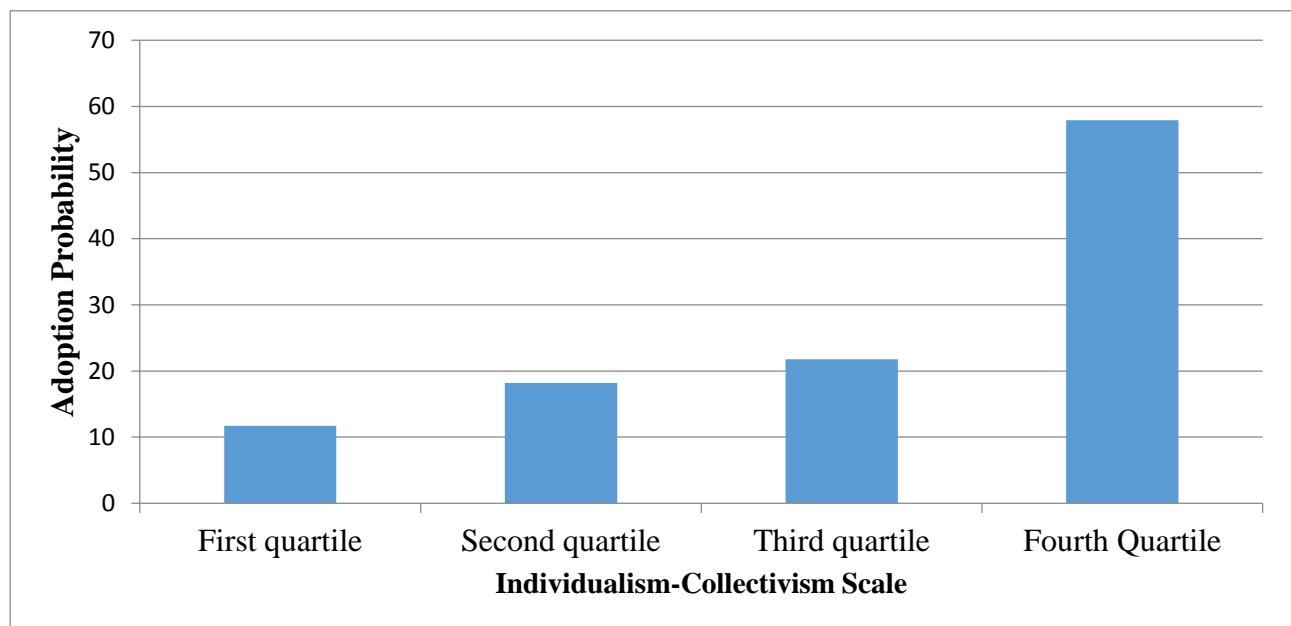

Figure 4. Predicted Probabilities for Suicide Bombing Adoption Based on the Organization's Collectivism Quartile, for 2006

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[23] More groups who use suicide bombings belong to the third and fourth quartile of collectivism, but the effect is not driven by any specific groups.

Discussion and Conclusion

In 1944, as Germany was losing the war, Adfolf Hitler was approached with a plan to create a "Suicide Group" of pilots to fly suicide missions against high-value targets (Gilbert 1989). Hitler's first response was to reject the idea 'completely' but he eventually agreed to set up an experimental unit. Pilots in this unit signed an oath "I hereby voluntarily apply to be enrolled in the suicide group as pilot of a human glider-bomb. I fully understand that employment in this capacity will entail my own death." (ibid: 504). The plan was later modified to give pilots a chance to eject before they hit the target. Nonetheless the program resulted in a major outcry of protest and three months after the unit's formation, the unit was disbanded. German military leaders helped convince Hitler that "suicide attacks were not part of the tradition of German warriors" (Zaloga 2005:39).

In the same year, as Japan was realizing that it was losing the war, Japanese military leaders have decided to create a special squadron of suicide bombers, known as Kamikaze (divine wind). On October 25th the first kamikaze plane hit the deck of the American aircraft carrier the *St Lo,* igniting munitions stored below deck and sinking the carrier within half an hour (Gilbert 1989:606). By the time the war ended more than 5,000 kamikaze soldiers had died, sinking 34 American ships (ibid).

Why did, one of the most ruthless military regimes in human history choose to reject a potentially effective tactic as violating its cultural tradition, while another embraced it. Both states were facing military defeat and invasion and yet only one chose to resort to suicide bombings as a tactic. What accounts for this? We would argue that collectivism-individualism may provide a fruitful answer. Every society, collectivist or individualist honors sacrifice in battle but the adoption of extreme sacrifice in the form of certain death in killing the enemy such

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as the practice of human-wave attacks against heavy artillery by China in the Korean War and the North Vietnamese during the Vietnam War; the case of persons climbing under tanks and detonating themselves during the Iran-Iraq War has been observed among collectivist nations (Reuter 2004)[24].

The existing perspectives on suicide bombing pose a deeper puzzle on the role of strategic value as well as ideological imperative on the diffusion of innovations generally. The strategic value account stresses a tactic's utility and claims that the incentives to use, from a purely instrumental perspective, appear substantial. In the case of suicide bombings, unlike other weaponry favored by terrorist organizations such as rocket-propelled grenades, improvised explosive devices based on a timer, a remote control, or a cell phone detonation mechanism, human guided smart bomb appear far more devastating and controllable. They have a much higher casualty rate, they are more likely to reach the target, are mobile, are relatively cheap, and can react to contingencies in real time. They are, after all, directly guided by the human brain. But why hasn't the tactic been more widely adopted by other insurgent organizations? If efficacy is the driving logic then we should not see a pattern of adoption based on a cultural variable, as our results show, since the desire to be effective transcends culture. We have shown that the adoption of this tactic by an organization is not only a function of the practice's utility. It has to mesh with the values, beliefs, and attitudes of the members of the organization and more critically with that of their supporters. Furthermore because the costs of the tactic are not uniform

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[24] A more complicated case involves Russian anarchists at the turn of the 20th century. There have been instances where the Russian anarchist detonated bombs when discovered that also killed them or have undertaken missions whose escape was unlikely and once caught were almost certain to not have their life spared. While some scholars might argue that these are really "contingent suicide attacks" and that there was no evidence that Narodnaya Volya had undertaken a systematic policy of suicide bombings, the case is instructive. There are some isolated instances of Soviet commanders ordering suicide-like missions but the tactic has to be policy in the form of a "suicide unit" not a matter of isolated circumstances. We therefore chose not to include the Russian case as evidence despite it favoring our hypothesis, as Russia is a relatively collectivist country – presumably even more so at the turn of the century and during the Communist era.

across actors but vary systematically based on cultural orientations, the *net* value of a tactic will depend on the kinds of costs that a culture imposes on it. A major insight is that the costs and benefits of a tactical innovation are not only derived from the internal features of the tactic itself in the likelihood of achieving a desired goal, but also from the cultural resonance the tactic produces. Culture is an important mediator of adoption cost and any rational choice model needs to take this into consideration.

Religious ideology, Islamism in particular, plays a role in the diffusion of suicide bombings. However, this mechanism leaves certain points unexplained. In particular it is not clear why so many non-Muslim as well as secular groups also adopt the tactic. The cultural resonance account presented here fills this lacuna. We identify a mechanism that explains suicide bombing adoption among ideologically and ethnically diverse users and specify the conditions under which such users adopt this tactic.

While we found that there was no interaction effect between collectivism and religion, it is still possible that collectivism is partially mediated by religion. Assessing this possibility was not feasible using the current data and the event history framework. That is because the collectivism scores and the religion variables are invariant with time in these data[25]. However, assessing a mediation effect is possible in principle. An ideal dataset that would allow such an assessment would contain collectivism scores for groups that varies over time as well as ideological change over time, as some groups may change their ideology. This would allow one to estimate an effect of group collectivism on group religious ideology.

Focusing on the innovation's strategic value or the adopter's ideological imperative are not sufficient explanations for an innovation's diffusion. It is also valuable to consider the

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[25] Or to use event history analysis jargon, they are not time-varying covariates.

cultural resonance of the innovation because culture may change the constitution of the actor, lower (or raise) the costs of adoption, and either allow or disallow the tactic as a conceivable option.

Furthermore, this study speaks to the quantitative diffusion literature on the role of culture (specifically cultural dimensions) and cultural resonance in the spread of innovations. This paper demonstrates how diffusion studies in general and studies of suicide terrorism in particular can incorporate cultural dimensions in a deductive research framework. Although culture has been recognized as an important factor in the spread of innovations, most of these works do not measure culture systematically (Rogers 2003 [1962]; Rosero-Bixby and Casterline 1993; Straub 1994). Without a rigorous measure claims about cultural resonance and innovation adoption invite all sorts of ad hoc theorizing – any innovation can be claimed to "fit" a culture in which it is widely diffused. We provide a roadmap of how claims about cultural resonance can be systematically tested and provide mechanisms that link the salient cultural dimension and the innovation.

A key implication of our study is that culture not only sets the kinds of goals that actors follow but also constrains the kinds of tactics they may adopt to achieve those goals. Demonstrating this dynamic among political parties may not have been impressive since such actors already accept the institutional order and its norms. However, the fact that this dynamic occurs even among actors who operate outside the legal norms of society by using violence and coercion, is particularly striking.

Finally, there are a number of extensions for future research that merit mentioning. It would be valuable to test the link between collectivism and other high-cost innovations, particularly other sacrificial innovations. Sacrificial innovations are innovations that require the

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sacrifice of either the adopter or a part of the adopter (if the adopter is a collectivity). Note that in the case of suicide bombings, the adopter is not the individual suicide bomber but the organization that deploys him. Other examples of such sacrificial innovations are social movement repertoires of self-immolations (such as the one that, more recently, launched the Arab Spring), military tactics of human wave attacks, and perhaps even uses of chemical, biological, radiological, or nuclear weapons (when the user knows that the consequence may involve the death of part of their own population as well). Chemical, biological, radiological, and nuclear weapons invite severe responses due to high-casualty rates. It may be that collectivist actors are less deterred by such reprisals and are willing to accept the sacrifice of their populations, then individualists. In this case they may be more willing to use such weapons than individualists.

Considering other cultural dimensions beyond collectivism-individualism may be especially fruitful. Indeed some cultural dimensions may actually intersect. Particularly promising are the power distance measure and the new indulgence-restraint measure (see Hofstede, Hofstede, Minkov 2010). Triandis's distinction between vertical and horizontal collectivists (and individualists) may also add some explanatory leverage (Probst, Carnevale, and Triandis 1999; Singelis et al. 1995). Vertical collectivists (high on Hofstede's collectivism and power distance dimensions) are more likely to obey leaders and subordinate their interests to the group. For example in the case of suicide bombings this may explain the susceptibility of such individuals to recruitment into suicide missions.

We hope to have made contributions on several levels. At the substantive level we gave a deeper sociological account to the debate among researchers, from various schools of thought, on what accounts for the devastating growth of the phenomenon of suicide terrorism. At the

theoretical level we introduced a promising theory – cultural resonance theory - in helping to understand what drives the diffusion of innovations. More generally we hope to have contributed to the recent resurgence of interest among sociologists in the role of culture in explaining social phenomenon. There is a growing consensus in sociology that culture matters. However, there is much less consensus on what "culture" is and how to best conceptualize it. This article offers a direction in how to incorporate this slippery construct in a systematic quantitative way when testing claims about the importance of culture. We believe that this approach to culture is promising and hope that it will be extended to other research questions.

Appendices

Appendix A: List of Terrorist Organizations and their Collectivism Scores

Terrorist Organization	Collectivism Score
1920 Revolution Brigades*	0.96065
23rd of September Communist League	0.3063
2nd of June Movement	-0.5876
Abu al-Rish Brigades	0.54085
Abu Hafs al-Masri Brigade*?	0.65259
Abu Nidal Organization	0.54085
Abu Sayyaf Group*	0.60064
Achik National Volunteer Council	0.27248
Action Commitee of Winegrowers	-0.4931
Action Directe	-0.4931
Aden Abyan Islamic Army	-0.0446
Adivasi Cobra Force	0.27248
Affiche Rouge	-0.4931
African National Congress	-0.9291
Akhil Krantikari	1.86656
al-Ahwal Brigades	0.96065
al-Aqsa Martyrs Brigades*	0.54085
al-Arifeen*	1.00729
al-Badr?	1.00729
Albanian National Army	0.53406
al-Bara Bin Malek Brigades*	0.96065
al-Barq	1.00729
Alex Boncayao Brigade	0.60064
al-Faruq Brigades*	0.96065
al-Fatah*	0.54085
al-Fuqra	1.007
al-Gama'A al-Islamiyya*	0.49834
al-Haramayn Brigades*	-0.0446
Ali Bin Abu Talib Jihad Organization	0.96065
al-Ittihaad al-Islami	0.42745
All Tripura Tiger Force	0.27248
al-Madina	1.007
al-Mansoorain*	1.00729
al-Qa'ida in the Arabian Peninsula*	-0.0446
al-Qa'ida Organization in theLand of theTwo Rivers*	0.96065

al-Qa'ida*	0.61688
al-Qaeda Organization in the Islamic Maghreb (Salafist Group for Call and Combat)*	0.69114
al-Quds Brigades*	0.54085
al-Sadr Brigades	0.1974
al-Saiqa	0.54085
al-Umar Mujahideen	1.00729
al-Zulfikar	1.00729
Amal*	0.1974
American Front	-1.0379
Andres Castro United Front	0.198
Animal Liberation Front	-1.0379
Ansar al-Islam*	0.96065
Ansar al-Jihad	0.96065
Ansar al-Sunnah Army*	0.96065
Anti-Communist Command	1.34976
Anti-Imperialist Cell	-0.5876
Anti-Imperialist International Brigade[?]	-0.2045
Anti-Imperialist Territorial Nuclei for the Construction of the Fighting Communist Party	0.0385
Anti-Power Struggle	0.05657
Anti-Terrorist Liberation Group	-0.2512
April 19 Movement	0.7822
Arab Liberation Front	0.54085
Arizona Patriots	-1.0379
Armata Corsa	0.0385
Armed Forces of National Liberation	-0.9106
Armed Forces of National Resistance	0.6269
Armed Islamic Group*	0.69114
Armed Revolutionary Left[?]	1.27614
Armenian Revolutionary Army*	1.31739
Armenian Secret Army for the Liberation of Armenia	1.31739
Army for the Liberation of Rwanda	0.55929
Army of God	-1.0379
Army of the Corsican People	0.0385
Army of the Followers of Sunni Islam	0.96065
Aryan Nations	-1.0379
Asbat al-Ansar	0.54085
Aum Shinrikyo	-0.2045
Babbar Khalsa International*	0.27248
Baloch Liberation Army	1.00729

Basque Fatherland and Freedom	-0.2512
Battalion of the Martyr Abdullah Azzam	0.49834
Bersatu	0.57701
Birsa Commando Force	0.27248
Black Liberation Army	-1.0379
Black Panthers	0.54085
Black Star	0.05657
Black Widows*	0.6291
Bodo Liberation Tigers	0.27248
Bolivarian Liberation Forces	0.51186
Borok National Council of Tripura	0.27248
Breton Revolutionary Army	-0.4931
Brigade 313	1.00729
Brigades of Imam al-Hassan al-Basri	0.96065
Brigades of the Victorious Lion of God	0.96065
Cambodian Freedom Fighters	0.57701
Carapaica Revolutionary Movement$^?$	0.51186
Catholic Reaction Force	-0.3986
Chadian People's Revolutionary Movement	0.61626
Charles Martel Group	-0.4931
Che Guevara Brigade	0.09762
Chukakuha	-0.2045
Cinchoneros Popular Liberation Movement	0.84221
Clandestini Corsi	0.0385
Colonel Karuna Faction*	0.27248
Committee for the Security of the Highways	-0.5445
Communist Party of India-Maoist	0.27248
Communist Party of Nepal-Maoist	1.86656
Communist Workers Movement	0.6291
Continuity Irish Republican Army	-0.3986
Cooperative of Hand-Made Fire and Related Items	0.0385
Corsican Revolutionary Armed Forces	0.79549
Covenant Sword and Arm of the Lord	-1.0379
Croatian Freedom Fighters	-0.012
Dagestan Liberation Army	0.6291
Dagestani Shari'ah Jamaat	0.6291
December 20 Movement	1.05525
Democratic Front for the Liberation of Palestine*	0.54085
DHKP/C*	0.6291
Dima Halam Daoga	0.27248
Divine Wrath Brigades	0.96065

Dukhtaran-E-Millat	1.007
Earth Liberation Front	-1.4661
East Turkistan Liberation Organization	1.00729
Eastern Turkistan Islamic Movement	1.00729
Ecuadorian Rebel Force	1.27614
Egypt's Revolution	0.49834
Egyptian Islamic Jihad*	0.49834
Ejercito Del Pueblo En Armas	0.51186
Eritrean Islamic Jihad Movement	0.42745
Eritrean Liberation Front	0.42745
Eritrean People's Liberation Front	0.42745
Ethiopian People's Revolutionary Army	0.47646
Ethnocacerista	0.56083
Evan Mecham Eco-Terrorist International Conspiracy	-1.0379
Extraditables	0.7822
Farabundo Marti National Liberation Front	0.6269
February 28 Popular Leagues	0.6269
Fedayeen Khalq	0.815
Fighting Jewish Organization	-0.5445
First of October Antifascist Resistance Group	-0.2512
Five C's	0.0385
Francs Tireurs	-0.4931
Free Aceh Movement*	1.34976
Free Papua Movement	1.34976
Front for Defenders of Islam	1.34976
Front for the Liberation of Lebanon From Foreigners	0.1974
Front for the Liberation of the Cabinda Enclave	-0.9291
Fronte Di Liberazione Naziunale Di A Corsica	0.0385
Gazteriak	-0.4931
Global Intifada	-1.261
Group of Guerilla Combatants of Jose Maria Morelos Y Pavon	0.3063
Group of Popular Combatants	1.27614
Guardsmen of Islam	0.51755
Guatemalan Labor Party	0.84221
Guatemalan National Revolutionary Unity	0.84221
Guerrilla Army of the Poor	0.84221
Guevarista Revolutionary Army	0.7822
Hamas*	0.54085
Hammerskin Nation	-1.0379
Harakat al-Shuhada'A al-Islamiyah	0.1974
Harakat Ul-Ansar	1.00729

Harakat Ul-Jihad-I-Islami*	1.00729
Harakat Ul-Jihad-I-Islami/Bangladesh	1.3596
Harakat Ul-Mujahidin	1.00729
Hector Riobe Brigade	-0.9106
Hisba	0.61626
Hizballah*	0.1974
Hizb-I Islami Gulbuddin*	1.00729
Hizbul Mujahideen*	1.00729
Holders of the Black Banners	0.96065
Iduwini Youths	0.61626
Indigenous People's Federal Army	0.60064
Informal Anarchist Federation	0.0385
International Solidarity	0.0385
Iparretarrak	-0.4931
Iraqi Legitimate Resistance	0.96065
Iraqi Revenge Brigades	0.96065
Irish National Liberation Army	-0.3986
Irish Republican Army	-0.3986
Islami Chhatra Shibir*	1.3596
Islami Inqilabi Mahaz	1.00729
Islamic Action in Iraq	0.8148
Islamic Army in Iraq*	0.96065
Islamic Great Eastern Raiders Front*	0.6291
Islamic International Peacekeeping Brigade	0.6291
Islamic Jihad Brigades	0.96065
Islamic Jihad Group*	1.00729
Islamic Liberation Organization	0.49834
Islamic Movement for Change[?]	0.2481
Islamic Movement of Uzbekistan*	1.00729
Islamic Resistance Brigades	0.96065
Islamic Salvation Front	0.69114
Islamic Shashantantra Andolon	1.3596
Jagrata Muslim Janata Bangladesh	1.3596
Jaime Bateman Cayon Group	0.7822
Jaish al-Taifa al-Mansoura*	0.96065
Jaish-E-Mohammad*	1.00729
Jaish-Ul-Muslimin	1.00729
Jamatul Mujahedin Bangladesh*	1.3596
Jamiat Ul-Mujahedin	1.00729
Jammu and Kashmir Islamic Front	1.00729
Janashakti	0.27248

Japanese Red Army	-0.2045
*Jemaah Islamiya**	1.34976
*Jenin Martyr's Brigade**	0.54085
Jewish Defense League	-1.0379
Jihad Committee	0.27248
Jordanian Islamic Resistance	1.08726
*Jund al-Sham**	0.60837
June 16 Organization	0.6291
Justice Army of Defensless People	0.3063
Justice Commandos for the Armenian Genocide	1.31739
Kabataang Makabayan	0.60064
Kach	-0.5445
Kahane Chai	-0.5445
Kakurokyo	-0.2045
Kanglei Yawol Kanna Lup	0.27248
Kangleipak Communist Party	0.27248
Karbi Longri North Cachar Hills Resistance Force	0.27248
Kenkoku Giyugun Chosen Seibatsutai	-0.2045
Khmer Rouge	0.57701
Knights of the Tempest	0.54085
Komando Jihad	1.34976
Kosovo Liberation Army	0.53406
Ku Klux Klan	-1.0379
Kuki Liberation Army	0.27248
Kuki Revolutionary Army	0.27248
Kumpulan Mujahidin Malaysia	0.434
Kurdistan Freedom Hawks	0.6291
*Kurdistan Workers' Party**	0.6291
Lashkar-E-Jabbar	1.00729
*Lashkar-E-Jhangvi**	1.00729
*Lashkar-E-Taiba**	1.007
*Lashkar-I-Omar**	1.00729
Laskar Jihad	1.34976
Lautaro Youth Movement	0.198
Lebanese Armed Revolutionary Faction	0.1974
Lebanese Liberation Front	0.1974
*Lebanese National Resistance Front**	0.1974
*Liberation Tigers of Tamil Eelam**	0.27248
Libyan Islamic Fighting Group	0.1974
Lord's Resistance Army	0.55929
Los Macheteros	-0.9106

Loyalist Volunteer Force	-1.4272
Mahdi Army	0.96065
Manuel Rodriguez Patriotic Front	0.198
Manuel Rodriguez Patriotic Front[∞]	0.198
Maoist Communist Center	0.27248
Martyr Abu-Ali Mustafa Brigades	0.54085
Masada Action and Defense Movement	-0.4931
May 15 Organization for the Liberation of Palestine	0.54085
May 19 Communist Order	-1.0379
Montoneros	0.09762
Morazanist Front for the Liberation of Honduras	0.84221
Morazanist Patriotic Front	0.84221
Moro Islamic Liberation Front*	0.60064
Moro National Liberation Front	0.60064
Moroccan Islamic Combatant Group	0.61404
Movement for Democracy and Development	1.64317
Movement for Democracy and Justice in Chad	0.61626
Movement for the Emancipation of the Niger Delta	0.61626
Movement of the Revolutionary Left	0.198
Movsar Baryayev Gang	0.6291
Mozambique National Reisistance Movement	-0.9291
Mujahedin-E-Khalq*	0.815
Mujahideen Kompak	1.34976
Mujahideen Message	1.00729
Mujahideen Shura Council*	0.96065
Muttahida Qami Movement	1.007
Nation of Yahweh	-1.0379
National Anti-Corruption Front	0.61095
National Army for the Liberation of Uganda	0.55929
National Democratic Front of Bodoland	0.27248
National Front for the Liberation of Angola	-0.9291
National Front for the Liberation of Kurdistan	0.6291
National Liberation Army	0.61095
National Liberation Army (Colombia)	0.7822
National Liberation Front of Tripura	0.27248
National Patriotic Front of Liberia	0.98593
National Socialist Council of Nagaland-Isak-Muivah	0.27248
National Union for the Total Independence of Angola	-0.9291
New Armenian Resistance	1.31739
New People's Army	0.60064
New Red Brigades/Communist Combatant Party	0.0385

New Revolutionary Alternative	-0.4926
November's Children	0.05657
Odua Peoples' Congress	0.61626
Ogaden National Liberation Front	0.42745
Omega-7	0.7303
Orange Volunteers	-1.4272
Order	-1.0379
Orly Organization	1.31739
Oromo Liberation Front	0.47646
Palestine Liberation Front	0.54085
Palestine Liberation Organization*	0.54085
Palestinian Islamic Jihad*	0.54085
Palestinian Popular Struggle Front	0.54085
Palestinian Revolution Forces General Command	0.54085
Parbatya Chattagram Jana Sanghati Samity	1.3596
Pattani United Liberation Organization	0.43372
Pedro Leon Arboleda Movement	0.7822
People Against Gangsterism and Drugs	-0.9291
People's Liberation Army	0.27248
People's Liberation Army of Kurdistan*	0.6291
People's Liberation Forces	0.7822
People's Liberation Forces	0.6269
People's Revolutionary Militias	1.27614
People's Revolutionary Organization	0.09762
People's Revolutionary Party of Kangleipak	0.27248
People's United Liberation Front	1.36
People's War Group	0.27248
People's Defense Forces (HPG)*	0.6291
Peykar	0.8148
Phineas Priests	-1.0379
Polisario Front	0.69114
Popular Forces of April 25	0.26977
Popular Front for the Liberation of Palestine General Command	0.54085
Popular Front for the Liberation of Palestine*	0.54085
Popular Liberation Army	0.7822
Popular Resistance Committees*	0.54085
Popular Revolutionary Action	0.05657
Popular Revolutionary Army	0.3063
Popular Self-Defense Forces	0.55929
Proletarian Combatant Groups	0.0385
Proletarian Nuclei for Communism	0.0385

*Prophet's Companions**	0.96065
Purbo Banglar Communist Party	1.3596
Rajah Solaiman Movement	0.60064
Real Irish Republican Army	-0.3986
Rebel Armed Forces	0.84221
Rebolusyonaryong Hukbong Bayan	0.60064
Recontra 380	0.84221
Red Army Faction	-0.5876
Red Brigades	0.0385
Red Flag	0.51186
Red Hand Defenders	-1.4272
Republic of Texas	-1.0379
Revolutionary Armed Forces of Colombia	0.7822
Revolutionary Armed Forces of the People	0.3063
Revolutionary Army	-0.2045
Revolutionary Eelam Organization	0.27248
Revolutionary Front for Communism	0.0385
Revolutionary Nuclei	0.05657
Revolutionary Offensive Cells	0.0385
Revolutionary Organization 17 November	0.05657
Revolutionary Organization of Socialist Muslims[?]	0.54085
Revolutionary People's Front	1.3596
Revolutionary People's Struggle	0.05657
Revolutionary Proletarian Initiative Nuclei	0.0385
Revolutionary Proletarian Nucleus	0.0385
Revolutionary Struggle	0.05657
Revolutionary United Front	0.98593
Revolutionary Worker Clandestine Union of thePeople Party	0.3063
*Riyad-Us-Saliheyn Martyrs' Brigade**	0.6291
Russian National Bolshevist Party	1.90118
Russian National Unity	-0.4926
Saif-Ul-Muslimeen	1.00729
*Salafia Jihadia**	0.61404
Salah al-Din Battalions	0.54085
Saraya al-Shuhuada al-Jihadiyah Fi al-Iraq	0.96065
Save Kashmir Movement	1.00729
Sekihotai	-0.2045
Self-Defense Groups of Cordoba and Uraba	0.7822
Shining Path	0.56083
Simon Bolivar Guerilla Coordinating Board	0.7822
Sipah-E-Sahaba Pakistan	1.00729

South Londonderry Volunteers	-1.4272
South Maluku Republic	1.34976
Southern Sudan Independence Movement	0.559
South-West Africa People's Organization	-0.9291
Sovereign Panama Front	1.05525
Spanish Basque Battalion	-0.2512
Special Purpose Islamic Regiment	0.6291
Students Islamic Movement of India*	0.27248
Sudan People's Liberation Army*	0.559
Sword of Islam	0.6291
Swords of Righteousness Brigades	0.96065
Syrian Social Nationalist Party*	0.1974
Takfir Wa Hijra	0.30905
Taliban*	1.00729
Tanzim	0.54085
Tawhid and Jihad*	1.02395
Tera Lliure	-0.2512
Territorial Anti-Imperialist Nuclei	0.0385
Tigray Peoples Liberation Front	0.47646
TKEP/L	0.6291
TKP/ML-TIKKO*	0.6291
Tontons Macoutes	-0.9106
Tunisian Combatant Group	0.69114
Tupac Amaru Revolutionary Movement	0.56083
Tupac Katari Guerrilla Army	0.61095
Tupamaro Revolutionary Movement	0.51186
Tupamaros	-0.3222
Turkish Hizballah	0.6291
Turkish Islamic Jihad	0.629
Turkish People's Liberation Front	0.6291
Uganda Democratic Christian Army	0.559
Ulster Defence Association/Ulster Freedom Fighters	-1.4272
Ulster Volunteer Force	-1.4272
Ummah Liberation Army	0.559
Underground Government of the Free Democratic People of Laos	0.57701
United Freedom Front	-1.0379
United Kuki Liberation Front	0.27248
United Liberation Front of Assam	0.27248
United National Liberation Front	0.27248
United People's Democratic Front	1.3596
United People's Democratic Solidarity	0.27248

United Popular Action Movement	0.198
United Revolutionary Front	0.51186
United Self-Defense Forces of Colombia	0.7822
United Self-Defense Forces of Venezuela	0.51186
United Tajik Opposition	1.00729
Up the IRS Inc.	-1.0379
Venceremos	0.51186
West Nile Bank Front	0.559
White Legion	1.27614
Yemen Islamic Jihad	0.286
Zapatista Army of National Liberation (EZLN)	0.3063
Zomi Revolutionary Army	0.27248

Footnotes

* Organizations denoted with an asterisk represent groups that adopted suicide bombing.

[?] Organizations denoted with a question mark represent groups whose authenticity as a terrorist group is doubted. All analysis was conducted with and without those organizations. Most such groups represent relatively short-lived entities and do not make much difference to the analysis.

∞ The Manuel Rodriguez Patriotic Front is listed twice because it existed for two time periods, having time-varying covariates on size and goal type for each of the periods. The RAND dataset lists it as effectively two separate organizations and we follow this convention.

Appendix B: How the Collectivism Scale Was Constructed

Our dataset included terrorist organizations from 76 countries and some of the countries included immigrant groups like the Kurds in Germany, or minority groups such as the Palestinians in Israel, Whites in South Africa, or the Dagestanis in Russia. We scoured the literature for collectivism measures that apply to both countries and ethnic groups. No single scale reported scores for all of our countries and ethnic groups. To minimize imputation we decided to combine scores from six different scales of collectivism into a single measure. While there are some differences between the ways collectivism is measured and even termed, the metrics are highly correlated with each other. Moreover the authors themselves usually use each other's metrics as validators; showing that their dimensions are significantly correlated with the dimensions of another research team that taps a highly similar dimension of cross-cultural variation[31]. While there is likely to be some measurement error we are very confident that our combined metric provides scores that are at least ordinally correct.

The collectivism-individualism scores we used were generally produced by large research programs involving many collaborators, carefully translated, and administered in the respondents' native languages. Typically these research efforts are not only interested in collectivism-individualism but in a variety of cultural dimensions such as power distance, harmony, assertiveness, performance orientation, to name but a few. While many of these dimensions are unique to each research effort the one that overlaps most strongly and most

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[31] For Hofstede see "Validating IDV Against Data From Other Sources" p.219-225 in Hofstede (2001) for reported correlations with Schwartz, Trompenaars, World Values/Inglehart. For GLOBES see House et al (2004:475) Table 16.9 for a correlation table between their collectivism metric and Hofstede's as well as Schwartz's. For Schwartz see (2006:152) where he reports high correlations between his autonomy/embeddness dimension and Ingelhart's survival/self-expression dimension. For World Values/Inglehart see Table 2 in Inglehart and Oyserman (2004:83) that seeks to combine Hofstede, Inghehart, and Schwartz into a single scale and examines how much variation it explains. Trompenaars shows how his individualism-communiatarianism correlates with Hofstede's individualism-collectivism in Smith, Dugan, and Trompenaars (1996). Diener (1995:585) correlates Triandis's scores with Hofstede's scores.

consistently is collectivism-individualism.

The collectivism metric used in our paper is a composite measure of six such widely used and extensively validated dimension scores that measure collectivism at the country or ethnic group level. The scores we used are as follows and are discussed in greater depth below: the Hofstede Scores of Individualism-Collectivism (Hofstede 2001), the Trompenaars Scores of Individualism-Communitarianism (Trompenaars and Hampden-Turner 1998), the GLOBE Scores of Societal Collectivism (House et al. 2004), the Schwartz Scores of Embeddedness-Autonomy (Schwartz 1994), the Triandis Scores of Collectivism (Diener, Diener, and Diener 1995) and the World Values Scores of Survival-Self-expression developed by Inglehart (1997). Because many readers may not be familiar with those measures we felt it was important to discuss them in much greater depth, elaborating on how the scales were constructed, how the scores were assigned, the kinds of questions that were used, and how the data was collected.

The Hofstede Scores of Individualism and Collectivism

The first research program on country-level collectivism and individualism scores was initiated by Geert Hofstede with the publication of *Culture's Consequences* in 1980. Collectivism and individualism was one of five cultural dimensions that Hofstede was interested in studying. The first wave of data collection was of employees[32] of a major multinational corporation, IBM, in 50 countries. It included a total of 117,000 IBM personnel. The employees were matched across countries by all major socio-demographic dimensions except nationality. Data was collected in three modules. The first was in 1968, followed by one in 1972 (these were from IBM employees exclusively), followed by additions in 1982 (adding 10 more countries)

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[32] A lot of the critiques of Hofstede wrongly assume that Hofstede looked only at managers. In fact he looked at both managers and bottom-level employees. Moreover he shows that there are differences between the two groups.

and in 1993 with replication data from studies in locations other than IBM. This last study had data on 73 countries. In addition there were about 200 external (non-IBM) studies that supported Hofstede's cultural indexes with collectivism-individualism being the most robust dimension (Hofstede 2001: 503). In the realm of replication, six major studies (counting more than 14 countries) found individualism-collectivism to be the dimension that was most confirmed (ibid).

The questions used to measure individualism-collectivism were various "work goals". Work goals stressing independence from the organization were contrasted with work goals stressing organizational dependence. Questions that took the format "How important is it to you to…". For example: [Challenge] "how important is it to you to have challenging work to do – from which you can get a personal sense of accomplishment"; [Cooperation] "work with people who cooperate well with one another"; [Freedom] "have considerable freedom to adopt to your own approach on the job". The survey included 14 work goals in the original survey and additional goals, 16 more, were added in subsequent surveys (See Hofstede 2001: 214 for a full list, as well as Appendix 1:467-468). The work goal of having a job that leaves one sufficient personal time had one of the highest positive correlations with individualism and having a job where the co-workers co-operated well with one another had the highest negative correlation with individualism – or the highest positive correlation with collectivism (but not other dimensions). Answers to the goal questions were factor analyzed and it was found that more than a 50% of the variance in the country-mean scores could be explained by just two factors. The Individualism-Collectivism index was the first factor, accounting for 25% of the variation. Hofstede found that it was mainly affected by six work goals (ibid: 214), which formed the basis of the index. The scaling was transformed from 0 (extreme collectivism)—100 (extreme individualism).

The index was then validated against attitudes and behaviors that were associated with individualism-collectivism and was found to be predictive, controlling for other factors. Various geographic, social, and economic indicators were found to correlate well (see Hofstede 2001 for a review of the validation studies). Data was taken from Appendix 5: Summary of Country Index Scores (Hofstede 2001:500-502).

The Trompenaars Scores of Individualism-Communitarianism

This research effort was initiated by the management scholar Fons Trompenaars, who was interested in looking at cultural dimensions in corporate management styles. He began his work with a dissertation in 1985, for the Wharton School of Business (Trompenaars 1985)[33] in which he considered ten countries. In 1993 he published *Riding the Waves of Culture: Understanding Cultural Diversity in Business[34]*. By the time the book was published Trompenaars and colleagues surveyed 15,000 participants in 30 companies spanning 50 different countries. Each country had a sample of a minimum of 100 persons with similar backgrounds and occupations. Seventy-five percent of the people in the sample were managers, while the remainder was general administrative staff (Trompenaars and Hampden-Turner 1998:2). Eventually data on 50,000 cases in 100 countries was gathered. Out of Trompenaars' six dimensions, only individualism-collectivism has been validated by subsequent researchers (Smith, Peterson, and Schwartz 2002; Smith, Dugan, and Trompenaars 1996).

To construct the scale Trompenaars used questions based on value dilemmas loosely

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[33] The dissertation is available electronically from the University of Pennsylvania and from the ProQuest Dissertations database.

[34] The book is geared toward a popular audience, specifically business managers. Readers are urged to consult the academic articles cited rather than the book. However Appendix 2 by Peter Woolliams has a methodological discussion of the data, which is written in a style that is more suited for social scientists.

patterned on work by Parsons and Shils (1951). Questions elicit respondent's values by asking

them how they would respond in an imaginary vignette with forced choices. The following

example questions are taken from (Trompenaars 1985, Appendix Questionnaires – English

Version)

Two persons were discussing ways in which one could improve the quality of his life:
    A. One said: It is obvious that if one has as much freedom as possible, and the maximum
        opportunity to develop oneself, the quality of one's life would improve as a result.
    B. Another said: If the individual is continuously taking care of his fellow-men the quality
        of life of us all will improve, even if it obstructs individual freedom and individual
        development.
    Check one answer on the answer sheet on the following questions:
        1. Which of the two ways or reasoning do you think is usually best, a or b?
        2. In your opinion which of these two ways of reasoning, most other people in ….
        would usually think is best, a or b?

A man died leaving a family business to his children who are all adults and live near each other.
There are two different ways they can run the business:

    A. In some cases it is expected that each of the children will sell his or her own share of the
        business to the rest of the family in order to set up his or her own business completely
        separate from all the others.
    B. In other cases it is expected that all the children will keep their share of the business and
        work together to make it grow.

Check one answer on the answer sheet on the following questions:
    1. Which way do you think is usually best, a or b?
    2. In your opinion which of these two ways of reasoning, most other people in …. would
        usually think is best, a or b?

Here is a list of four types of people. Of those four, which type do you most prefer to have as
friends? Which do you prefer second most?
    A. People who completely accept you the way you are and feel responsible for your personal
        problems and welfare.
    B. People who do their work, attend to their affairs, and leave you free to do the same.
    C. People who try to improve themselves, and have definite ideals and aims in life.
    D. People who are friendly and lively, and enjoy getting together to talk or to socialize.
    Trompenaars and colleagues then performed a cluster-analysis to see if highly correlated

items cluster around the concepts being tested. In addition, validating interviews and cognitive

mapping were also used. Finally, an exhaustive quantitative analysis was applied to determine

the validity of alternative combination of questions at both the global level and the country level (Trompenaars 1998:246). The Cronbach's alpha for the collectivism questions is 0.73. Supplemental analysis using non-parametric data-mining techniques explored data variety, looking at the importance of attributes such as age, gender, religion, occupational position vs country in explaining the variation in the scale using. It was found that country differences had the lowest entropy of classification, meaning they were the best predictors of the scale and could not be explained away by individual-level differences such as age, gender, religion, or occupational position.

Unfortunatley Trompenaars did not make the full scale country-level scores publically available. Instead he listed country-level scores for only some of the items of his survey. This is the data that Hofstede used in his re-analysis of Trompenaars' data (See Hofstede 1996) where he found that two factors correlated most highly with his individualism scale, one of which used the three items listed in the chapter on individualism and collectivism. We used scores on those three items, which are listed for forty countries on a Hofstede-like scale of 0-100 in Trompenaars (1998) in Figure 5.1 (p.52), Figure 5.2 (p.55), and Figure 5.7 (p.53):

Two people were discussing ways in which individuals could improve the quality of life.
A. One said: "It is obvious that if individuals have as much freedom as possible and the maximum opportunity to develop themselves, the quality of their life will improve as a result."
B. The other said: "If individuals are continuously taking care of their fellow human beings the quality of life will improve for everyone, even if it obstructs individual freedom and individual development."

Which of the two ways of reasoning do you think is usually best, A or B?

1) Which kind of job is found more frequently in your organization?
   A. *Everybody works together and you do not get individual credit*
   B. *Everybody is allowed to work individually and individual credit can be received.*

2) *A defect is discovered in one of the installations. It was caused by negligence of one of the members of a team. Responsibility for this mistake can be carried in various ways.*
   A. *The person causing the defect by negligence is the one responsible.*
   B. *Because he or she happens to work in a team the responsibility should be carried by the group.*
   Which one of these two ways of taking responsibility do you think is usually the case in your society, A or B?

The sample-size was 30,000 respondents from Trompenaars' database, representing forty different countries. However, because the scale is incomplete we have also performed a robustness check by excluding the Trompenaars scores from our final scale. The results were in line with our original results.

The GLOBE Scores of Societal Collectivism

Another major research program was initiated in the mid-1990s that pooled together 170 social scientists and management scholars from 62 countries, representing the world's biggest regions. The respondents were 17,000 mid-managers from 951 organizations (House et al 2004:3). The sample was more than 25% female (ibid: 29). The data collection effort spanned 10 years in multiple phases and measured many different cultural dimensions including individualism and collectivism (Gelfand et al 2004).

The Individualism-Collectivism scale was further distinguished into four subtypes. It first distinguished between institutional collectivism and in-group collectivism. Institutional collectivism represents the extent to which institutional practices reward and encourage collective action. More specifically it seeks to identify the extent to which group loyalty is

emphasized over individual goals (Gelfand et al 2004:463). In-group collectivism focused on the family unit and sought to represent the extent to which individuals express loyalty, pride, and interdependence in their families. Next the scales sought to distinguish attitudes representing how things *are* (e.g In this society people are generally…) from how things *ought to be* (e.g. In this society people should…). The former were termed practices and the later were termed values. Thus four sub-types of collectivism were measured: institutional practices, institutional values, in-group practices, and in-group values. Each scale had about four questions.

Here are some example questions: In this society, leaders [ought to] encourage group loyalty even if individual goals suffer? In this society, children [ought to] take pride in the individual accomplishments of their parents? The responses were measured on a 1-7 scale from "Strongly Agree" to "Strongly Disagree" or "Individual Interest" to "Collective Interest" in questions such as The economic system in this society is [ought to be] designed to maximize. See Gelfand (et al 2004: 464-465) table 16a-g for a complete list of questions.

Out of the four sub-types the authors found that the two scales that best correlated with Hofstede's scale were In-Group Collectivism Practices at .82 and Institutional Collectivism Values at .55 Both correlations were statistically significant (See Gelfand et al 2004:475, Table 16.9) . These were the two collectivism scales we used as part of the GLOBES study. Data was taken from Table 16.7b and 16.7c (Gelfand et al 2004:469-470).

The Schwartz Scores of Autonomy and Embeddedness

Another research program was initiated by Shalom Schwartz. Schwartz was interested in the broader question of how individuals prioritize values across cultures and the effect this has on their attitudes and behaviors. He developed a scheme of value orientations, which represent

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ideals that guide people in prioritizing their values (Schwartz 1994; 2006). Once again the dimension that corresponds to collectivism-individualism is one of many dimensions he developed. Schwartz calls it autonomy-embeddedness, which refers to the extent to which persons draw boundaries between the individual and the group. Autonomy ideals direct that members of the culture "… should express their own preferences, feelings, ideas, and abilities, and find meaning in their own uniqueness" (Schwartz 2006:140). Embeddedness ideals emphasize how members of the cultures are "… entities embedded in the collectivity. Meaning in life comes largely through social relationships, through identifying with the group, participating in its shared way of life, and striving toward its shared goals." (ibid) In his initial work (Schwartz 1994) autonomy was distinguished into intellectual autonomy referring to emphasis on self-direction and affective autonomy referring to emphasis on stimulation and hedonism, while embeddedness was called conservatism. In his later work (Schwartz 2006) conservatism was renamed embeddness. These dimensions correspond conceptually most strongly to the individualism-collectivism concept and Schwartz found that they had the highest correlations with Hofstede's individualism-collectivism concept (see Table 7.2 Schwartz 1994: 109).

Data was gathered using the Schwartz Value Survey (SVS). The SVS data was gathered during the period of 1988-1992 representing 41 national groups and 38 countries. This represented 30 different languages and 12 religions including atheists. The samples were drawn from two types of populations: k-12 school teachers and college students. Samples were typically 150-300 respondents.

The survey questions are structured as follows. In order to express directly the definition of values as guiding principles in the life of a person or group, the survey asks respondents to rate each value "As a guiding principle in my life" using a scale from 7 (*of supreme importance*)

to 0 (*not important*) and -1 (*opposed to my values*). Respondents are then given a list of 56 single

values, which are selected to denote 11 universal types of individual-level values, with a short

description of the value listed in parenthesis. Here is an example:

INDEPENDENT (self-reliant, self-sufficient)

CHOOSING OWN GOALS (selecting own purposes)

SENSE OF BELONGING (feeling that others care about me)

FREEDOM (freedom of action and thought)

For the complete list and the instrument see Appendix of Schwartz (1992: 60-62). Unlike

Hofstede's and Inglehart's dimensions, which were derived from a factor analysis of of survey

responses, Schwartz hypothesized a priori which values should go together and then confirmed

and elaborated his theory, using a non-metric multidimensional scaling, using the gathered data.

Intellectual autonomy represents a cluster of values such as curiosity, broadmindedness, etc;

intellectual autonomy represents a cluster of values such as pleasure, exciting life, varied life,

etc; while embeddness represents values such as respect for tradition, family security, preserving

public image, etc. Schwartz (2006:152) reports high correlations between his

autonomy/embeddness dimension and Ingelhart's survival/self-expression dimension. He states

that "Given the differences in the way the dimensions were derived, in the scales used to

measure them, and in the nature of the samples studied, this overlap is striking. It strongly

supports the idea that these dimensions capture real, robust aspects of cultural difference"

(ibid:153).

The data for Schwartz's metrics was taken from Table 7.3 (Schwartz 1994:112-115).

The Triandis Scores on Collectivism

Another set of scores were produced by Harry Triandis, one of the most prominent and prolific researchers of the collectivism-individualism literature. The measure was created for Ed Diener, who asked Triandis to rate 55 countries on a scale of 1 to 10 with 1 being the most collectivistic and 10 being the most individualistic (Diener et al 1995). Triandis was unaware of the data being used or the hypothesis being examined by Diener. Diener correlated Triandis's scores with Hofstede, on overlapping countries, and found they were highly correlated at .83 (ibid:858).

He also found Triandis's measure to predict another indicator of collectivism-individualism – the divorce rate. Diener et al (1995) argued that divorce rate reflected individualism because nations where divorce is easy and the rates of divorce are high reflects the value of the importance of the rights and happiness of the individual over the importance of the collective relationship. Divorce reflects the seeking of individual goals and happiness over obligation, duty, obedience, and other collective values. Members of high divorce societies see marriage as not necessarily a lasting institution but one that is temporary if the personal returns are outweighed by the costs and it is accepted that entering into a marriage may still mean that the individual will need to ultimately rely on themselves.

While it would be more desirable if the scale was constructed in a more systematic way, we note that Triandis is considered a leading expert in the field as the founder of cross-cultural psychology. Moreover, Triandis's scores, averaged with Hofstede's scores, have been used by numerous cross-country comparison work, published in top journals (see Allik and Realo 2004; Lucas et al. 2000; Oishi et al. 1999; Suh et al. 1998). We used the data from Table 1 of Diener et al (1995:856).

The World Values Scores on Survival and Self Expression

Perhaps one of the most well-known projects in the study of culture is the World Values Survey. Originally confined to 14 European countries in the form of the European Values Survey, the project was started by Dutch researchers in 1981. In was gradually extended beyond Europe by Ingleheart and colleagues in the form of the World Values Survey, which took place in five waves and is still continuing. The waves are 1981-1984; 1990-1994; 1995-1998; 2000-2004, and 2005-2009 and include 97 countries, covering more than eight-five percent of the world's population. All surveys include nationally representative samples.

Using a factor analysis Inglehart (1997) found that two dimensions explained over 70% of the cross-national variation in a set of variables capturing basic values on a wide spectrum of items from politics and economic life to sexual behavior. From those two factors he constructed two scales: the traditional/rational scale and the survival/self-expression scale. Survival refers to circumstances where persons are concerned with physical and economic security. Self-expression refers to a concern with quality of life issues, once survival needs have been met[35]. The scale is therefore linked with societal wealth and level of industrialization. The scale was reduced to five indicators, which were found to be predictive of other expected attitudes and behaviors. For example respondents who scored high on survival and low on self-expression were more likely to give priority to economic and physical security over quality of life and self-expression; were less likely to sign a petition, and were more likely to endorse the view that one has to be very careful when dealing with people (beyond their ingroup). For the complete list of items see Table 2.1 in Inglehart & Welzel (:49).

This dimension was discovered to be highly correlated with Hofstede's collectivism-

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[35] One can think of them as descending up the last rung on Maslow's Hierarchy of Needs.

individualism index and Schwart'z autonomy-embeddness index. Inglehart and Oyserman (2004:83) found that when combined it explained 87% of the variance in Hofstede's individualism-collectivism scores and 87% of Schwartz' autonomy-embeddnes scores.

Data was taken from Inglehart(2010). Given Inglehart's finding that the dimensions are remarkably persistent over time (Inglehart & Welzel 2007:6), we used an average score, across the five waves, to construct our scale.

Constructing our Combined Collectivism Scale

The final score was constructed by computing an inter-item correlation score for all pairs of the above metrics for each country or ethnic group. Since the measures are scaled differently (e.g. Hofstede is 0-100, GLOBES 1-7, Triandis 0-10), we took the mean of standardized scores to construct the index. The resulting collectivism/individualism index is reliable ($\alpha=0.81$). The scores ranged from -2 to 2, with the anchor points denoting most individualistic to most collectivistic groups respectively. Countries not in the data were imputed using the method described in part two of the appendix. The mean level of collectivism, for the countries we had terrorist organization data on, was 0.42 with a standard deviation of .62. The most collectivist country was 1.9 and the most individualist was 1.47. For the most part, the country scores obey Tobler's law[36], which is to say that entities close to one another are more similar than those further away. This is especially the case if they share a common language, religion, and history.

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[36] For a review of Tobler's law, see the discussion in the 2004, Volume 94, issue 2 *Annals of the Association of American Geographers*.

Appendix C: Imputation Procedure

The final scale provided information on 60 ethnic groups representing 336 organizations. However this still left 32 ethnic groups to be imputed since their scores were not listed in any dataset. The imputations represented 79 cases (out of 415 or about 20% of the cases). Some works that have used Hofstede's data imputed missing values by taking geographic regional mean scores (Scherer 1997). However, one has to be careful in inferring cultural characteristics of terrorist groups from their nations. Some terrorist groups don't accept the national culture of the state they are fighting, some have been recently occupied, and some are recent immigrants. We have therefore opted for a somewhat less crude approach. Ethnic groups that needed to be imputed were divided into two groups: ethno-nationalist groups and national groups. The former included ethnic/ethnic groups who were clearly different from the host country/territory in which they conducted attacks (e.g. Palestinian Islamic Jihad in Israel, Arab cells in Europe, Tamils in Sri Lanka, Muslim Kashmiris in India, Chechens in Russia).

Imputation was done in the following manner. The base of the group's operations is taken as the foci. Next a geographic neighbor is identified that has data available, speaks the same language, and adheres to the same religion. For example the Tamils in Sri Lanka are assigned India's scores; Kashmiri's of India are assigned Pakistan's scores, Chechens in Russia are assigned Turkey's scores. Data on languages and religion were obtained from Fearon (2003) and Fox (2004) respectively. If there was doubt, the more conservative scores were assigned that would favor the null hypothesis. For example there were a large number of Palestinian groups, many of which conducted suicide attacks. We could have plausibly assigned scores based on Jordan which is more collectivist and whose population is more than half Palestinian. Instead we chose to assign scores based on Israeli Arabs, who are relatively more individualist compared to

other Arab countries, certainly compared to Jordan. Great care was taken to impute scores based on a neutral systematic method that was blind to our research hypothesis.

The nationalist-group category included groups that share a culture with the host country in which attacks are launched; they typically included groups that were fighting for social revolutionary change, for a religious revolution, or as right-wing groups seeking to preserve the status quo (e.g. Andres Castro United Front, Yemen Islamic Jihad, Recontra 380). Those groups get the score of the host country or of the geographic neighbor that has data available and which is culturally closest to the country. Transnational groups (Cambodian Freedom Fighters, Al Qaeda, Free South Moluccan Youth) are given the scores of the originating country. The scores for multinational terrorist groups such as al-Qa'ida were coded based on the average score of the predominant ethnic groups that made up the membership of the organization. For example, based on the TOPS (2010) database al-Qa'ida was composed of Saudis, Egyptians, Jordanians, Iraqis, Syrians, Algerians, Moroccans, Palestinians, and Afghanis. We therefore pooled the collectivism scores for each of those groups and assigned the mean score to al-Qa'ida. We have also tried pooling scores based on the top leadership of the organization only (e.g. Saudi Arabia and Egypt in the case of al-Qa'ida). Our results were consistent with this alternative assignment procedure.

To make sure that our analysis is not biased by our imputations we present models with and without the imputed scores. A list of all groups and their collectivism scores can be found in appendix A.

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CHAPTER 2: UNDERSTANDING SELF-STARTER TERRORISM: A NETWORK MOBILIZATION PERSPECTIVE[37]

On July 22nd 2011 a right-wing extremist disguised himself as a Norwegian police officer and indiscriminately shot children at a summer camp (affiliated with a political party that he viewed as a threat.) When he was finished, 69 were dead and 110 were injured. The attack was considered one of the deadliest terrorist incidents in Norway's recent history. Six years earlier, on July 7th, 2005, four Islamic extremists detonated bombs on British subways as well as a bus. Their combined attack killed 52 people and injured approximately 700. All four were British citizens and all but one was born in Britain. Neither attack was motivated by mental illness or personal grudges. Instead both were carried out by mentally competent individuals, who carefully planned their attack, and were motivated by political ideologies. They were terrorist attacks, yet they were not directed by any pre-existing organization[38]. Instead they were carried out by individuals who organized themselves, trained themselves, picked the targets themselves, and executed the attacks unassisted (Kirby 2007; Spaaij 2011). In the terrorism literature, this is referred to as self-starter terrorism[39] (Kirby 2007) and this kind of violence has been increasing since 2003 (Crone and Harrow 2011). While self-starter terrorism has captured the attention of the popular press, and there are good descriptive studies of the phenomenon, the conditions and processes by which radicals mobilize into self-starter terrorism is not well-understood and under-

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[37] This paper is based on work in collaboration with Alexander Gutfraind. A co-authored paper based on this chapter is currently under review.

[38] There is some debate regarding the nature of the connection of the London cells to Al-Qaeda. A House of Commons investigation (House of Commons Report 2006:19-20) concluded that there is no evidence for the claim that the July 7th bombing has been directed by Al-Qaeda.

[39] Sometimes the term "home-grown terrorism" is used, when all the cases examined are actually self-starter. We believe this term is highly misleading since home-grown terrorism may involve long-established organizations. Moreover, home-grown individuals may volunteer for missions on behalf of a foreign organization. We define self-starter terrorism as terrorist acts that are carried out by small groups of individuals that are not recruited, directed, trained, or financed by any existing terrorist organization or state security agency and form primarily through the initiative of their members.

studied, compared to other forms of political violence such as organizational terrorism. As a consequence, no theory currently exists that explains when and where self-starter terrorism is likely to emerge.

Two literatures have developed that speak to the phenomenon, centering on either radicalization or mobilization. But while both illuminate important elements of self-starter terrorism they also leave critical aspects of the phenomenon unexplained. The radicalization literature helps us understand how people develop radical beliefs but not how they find one another and organize into attack units. The mobilization literature fills this lacuna but assumes a centralized recruiter on behalf of an organization or focuses too heavily on network ties among existing radicals and ignores the role of non-radicals in either facilitating or constraining the mobilization process. Thus the mobilization literature focuses on centralized mobilization, which is more relevant to organizational terrorism and less so for self-starter terrorism.

This paper is an effort to understand decentralized mobilization by unpacking the role that social networks play in both facilitating and constraining this kind of mobilization and hence providing a fuller theoretical account of self-starter terrorism. Our central explanatory idea is called the network mobilization readiness (NMR), which measures the manner in which the would-be terrorists are embedded in their social networks. We propose that a network's mobilization readiness can be measured and characterized along four specific dimensions. Certain network configurations, on those dimensions, may influence whether the mobilization is more likely to result in attack units consisting of one person (the so-called lone wolves) or groups of people (termed here wolfpacks). More importantly, these network configurations can influence whether the wolves and wolfpacks can mobilize successfully or whether their

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mobilization is interfered with via non-radicals within their network. We present two mechanisms by which this interference occurs: occlusion and encapsulation.

Next, we consider the kinds of ecological factors in a community that alter its network mobilization readiness and result in the different scenarios. To do so, we develop an agent-based computational model that represents a variety of ecological factors that influence the social network. The model shows how the factors influence NMR, and characterizes the strength and direction of this influence. Our model makes specific empirical predictions, some of which we validate using an empirical dataset of self-starter terrorism. The most important of our findings concerns how NMR is affected by the presence of social venues that mix radicals and non-radicals, which we call neutral magnets. We find that neutral magnets disrupt the formation of cohesive wolfpacks, but are not effective in reducing the threat of lone wolf attacks.

Our theoretical account of decentralized mobilization has counter-intuitive implications to both the scholars of self-starter terrorism as well as to the policy-makers seeking to mitigate this phenomenon. If a large amount of self-starter terrorism is "held back" by network constraints, rather than a shortage of radicals, then shifts in ecological factors that alter network constraints will unleash more violence. Importantly, this can occur even when there is no change in the number of persons who hold extremist attitudes. This shift in focusing on ecological and network factors has strong implications for empirical studies of self-starter terrorism. Estimating the likelihood of attacks by polling and measuring the size of the population that holds extreme opinions will produce misleading results. Surveys that attempt to measure the risk of mobilization (and hence violence) must also ask network generator and interpreter questions (see Marsden 1990). Specifically, it is not sufficient to know what percentage of the population holds extreme beliefs; it is also critical to know the beliefs of their associates (or more precisely their

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perception of beliefs) or how other radicals are embedded in the network. We discuss and develop this point in the conclusion.

From Radicalization Factors to Mobilization Processes

Scholarship on self-starter terrorism, to the extent it exists, has drawn from two related literatures: radicalization and mobilization. Both of these literatures contribute to our understanding of important facets of self-starter terrorism, but they also leave a number of critical questions unanswered.

The literature on radicalization, the process by which individuals or social groups develop the belief that violence is a legitimate instrument to achieve political goals, is prolific (see Moghaddam 2005; Post et al 2002; Borum 2011) but leaves a gap when applied to self-starter terrorism. Scholars of self-starter terrorism who draw on this literature focus on individual factors such as unemployment, discrimination, alienation (Kirby 2007), exposure to ideology (Spaaij 2011). Understanding how radical beliefs form in the first place is clearly important but a number of recent works have pointed out the limitations of focusing solely on radicalization (see Horgan 2012; McCauley& Moskalenko 2008). The most immediate problem is that the overwhelming majority of individuals with radical beliefs never commit violence (Kurzman 2011). For example 7% of British Muslims expressed admiration for "organizations like al-Qaeda that are prepared to fight against the West" (Mirza, Senthilkumaran, Ja'far 2007:62); this represents approximately 112,000 people. Yet remarkably, the numbers of violent plots that have been undertaken have been relatively small (Kurzman 2011). This suggests that understanding radicalization by itself is not sufficient.

Social movement scholars have long recognized the inadequacy of motivational explanations and also consider mobilization – the process by which activists mobilize into social

movements (Jenkins 1983; Klandermans 1984). But this literature too, leaves a number of gaps, when applied to explaining self-starter terrorism. Critical to mobilization is the role of social networks among activists (McAdam 1988; Diani & McAdam 2003) and social movement entrepreneurs/recruiters (Jenkins 1983). This insight has been fruitfully applied by researchers to terrorist organizations and their recruitment of members (Sageman 2004). However, it is substantially more difficult to apply mobilization ideas from social movements to self-starter cells. There are two reasons for this. First, unlike established terrorist organizations, self-starter cells include only a few members (and sometimes only one) and, unlike most social movements, cannot mobilize freely and openly. Second, unlike non-violent tactics used by social movements that require large and public masses of people to be effective, violent tactics can be effective and sometimes require (to prevent interception by authorities) a relatively small and secretive group. But while networks between activists and centralized recruiters may be less relevant to self-starter terrorism than they are to organizational terrorism, this does not mean that networks do not play a role in mobilization. Indeed it is precisely the small, clandestine, and poorly institutionalized nature of self-starter cells that make networks play a critical role. But the role networks play for this kind of terrorism is markedly different than the role they play in organizational terrorism.

To understand how networks matter for mobilization into self-starter terrorism, it is first helpful to distinguish between two types of mobilization. Centralized mobilization involves a pre-existing structure that helps to recruit and socialize new members from the top down. Decentralized mobilization involves radical individuals finding like-minded others or radicalizing existing relationships and is bottom-up. The key distinguishing feature is that there is no recruiter role. Centralized mobilization faces a trust problem and recruiters face a critical

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role in screening for trustworthy individuals (Hegghammer 2013). Moreover, all the members are tied to the recruiter and the terrorist organization, which may have a record of violence. By contrast, decentralized mobilization is contained to just the self-mobilized individuals.

Most efforts to understand mobilization focus on centralized mobilization. The goal of this paper is to understand decentralized mobilization because it is absolutely central to the phenomenon of self-starter terrorism. To this end we deploy the following theoretical framework, which contains two parts. First, we seek to recast decentralized mobilization as a function of a particular set of network configurations, which correspond to mobilization outcomes that are either complete or incomplete, and involve either groups or individuals. Second, we seek to understand how such network configurations are produced by focusing on the ecological processes that are influencing the network configurations resulting in the various mobilization scenarios.

Mobilization as a Network Problem

To be precise, by mobilization we mean the process by which existing self-starter radicals, who are willing to carry out terrorism, form their attack unit. The attack unit could be just one attacker or multiple individuals. The mobilization process may overlap with training, planning and arming but may be completed beforehand – all that is required is that the radicals have committed to their participation. Once mobilized, the ability of any specific unit to successfully carry out the attack is determined by many factors such as evasion from authorities, procurement of weapons, among others, which are outside the scope of this study.

The key assumption guiding our work is that the right-level of analysis to understand mobilization is at the network level rather than the individual level. To illustrate this more

clearly, it is helpful to use a concrete example. Consider the 7/7 London bombers who were from the city of Leeds. Let us imagine we could have data for the entire social network of Leeds. Suppose we also had similar network data for a city of comparable size, such as Sheffield. Both cities contain a small percentage of radical individuals that will carry out violence if they can only find a few like-minded souls. In one city the radicals are within one-degree of separation to one another; in another they are ten degrees of separation. Can we characterize the networks of both of these cities such that it would be possible to tell whether one city has more readiness to have self-starter terrorism than the other? What sort of network properties should one consider? We propose a theoretical idea that will help answer these questions called network mobilization readiness.

Network Mobilization Readiness: Fraction of Radicals, Isolation, Clustering and Cell Size

We define Network Mobilization Readiness as the extent to which the radicals of a particular community are organized into units capable of self-starter attacks. When NMR is increased, these units are composed of radicals who are connected to each other and isolated from the rest of the network. NMR is computed from the state of the social network of the community, containing both radicals and non-radicals. While the idea of NMR is potentially applicable to other phenomena, it is especially applicable to self-starter terrorism since most would-be self-starter terrorists face two problems. First, they live in Western societies where their militant views represent a tiny minority, even within the ethnic or religious communities they inhabit (Mirza, Senthilkumaran, Ja'far 2007). Most of their associates are not radicals. Second, their minority trait (violent ideology) is not easily observed and openly advertising it is dangerous. Therefore breaking out of their existing social network of non-radicals and finding

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other radicals is costly. However, this cost varies from one geographic community to another and is captured by each community's network mobilization readiness.

We propose a way to characterize the NMR using four precise metrics. They are: fraction of radicals – the number of radicals in the network divided by the total number of individuals; isolation – the extent to which radical individuals are themselves connected to like-minded colleagues but not to non-radicals; clustering – the cohesiveness of radical groups, and cell size – the mean number of radicals in an isolated grouping. The fraction of radicals quantifies radicalization, which is a prerequisite of the mobilization process, while the other three measures - isolation, clustering, and cell size – quantify the actual mobilization of the network. Combined together they paint a detailed picture of whether mobilization is occurring and how. As we shall argue, isolation reflects whether would-be radicals can escape the social constraints of the predominantly non-radical community, while clustering and cell size reflect whether mobilization takes the form of lone radicals (wolves) or groups of radicals (wolf-packs). We proceed to justify the relevance of the metrics to mobilization and then to operationalize them.

Isolation

Isolation describes the connectivity between radicals and non-radicals and can be thought of as the freedom from counter-veiling influence. Low isolation represents a condition where radicals are well-connected to the society at large including many non-radicals (Figure 1, boxes A and B). High isolation represents a condition where the radicals constitute an isolated subnetwork with no ties to non-radicals (Figure 1, boxes C and D). High isolation has the greater threat of violence since the radicals experience no restraining influence from non-radicals such as family and friends.
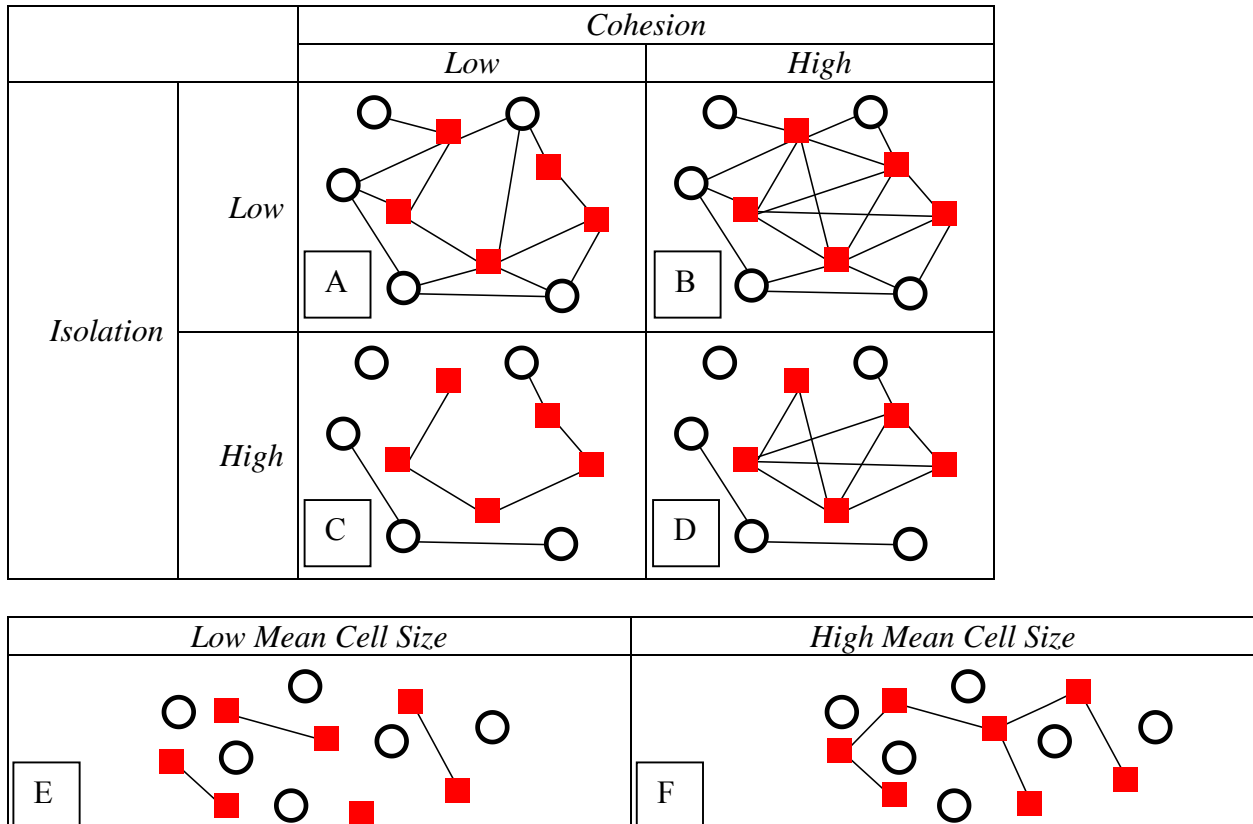
Figure 1. Three Network-Based Measures of Mobilization: Isolation, Cohesion and Mean Cell Size. When combined the measures define the four mobilization scenarios. The shaded squares represent radicals and the white circles represent non-radicals.

The role of other persons in one's network to restrain behavior (that one is otherwise inclined to do) has been well-documented. Social control theory in criminology argues that deviance is influenced by the extent to which a person has social bonds to the various institutions of society such as family, religion, and work (Gibbs 1989; Hirschi 1969). These bonds help to monitor and enforce the social norms that prevent a person from straying. Persons who had no obligations to family or careers and had little ties to voluntary/communal organizations were found to be more likely to engage in criminal or anti-social behavior (ibid). The social movement literature similarly argues that social ties may restrain individuals from participating in a

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movement action, despite enthusiastic support for the movement's goals. The classic study to make this point is that of the Mississippi Summer Project, a campaign to register black Americans to vote in a highly hostile area in the American South during the height of the Civil Rights Movement. McAdam (1988)studied the applications of volunteers to the project who mysteriously dropped out at the last moment and found that the top predictors of dropping out were parental opposition and biographical constraints such as marriage and pregnancy (McAdam 1988:57, see Table 2.2).

Anecdotal evidence from biographical profiles of persons engaged in self-starter terrorism usually mention how isolated they were prior to engaging in terrorism. Anders Breivik, the perpetrator of the 2011 Norway attacks, was revealed in court testimony, to have cut off ties to his friends six years before the attack (Fisher 2012). The leader of the London bombing cell, Mohammed Khan, was ostracized by his family after marrying a Hindu woman, while some of the cell members cut off ties to their families before they began preparing the attack (Herbert 2005). Less anecdotally, studies that compared Islamist homegrown terrorists with a sample of male Muslims have found the former to have lower ties to social institutions such as work; the Islamists were more likely to be unemployed than the Muslim sample, controlling for citizenship (Altunbas and Thornton 2011, 262-272).

A suitable measure of isolation is the difference between the number of radical-to-radical ties ("internal ties") and radical-to-non-radicals ties ("external ties") divided by the total number of ties. This is equivalent to the E-I index (Krackhardt and Stern 1988) multiplied by -1. Note that Isolation varies from -1 (lowest) to 1 (highest) and it increases if the fraction of radicals in the population increases, *ceteris paribus*.

It may be tempting to think that all radicals become automatically isolated from non-

radicals due to their beliefs, via selection. However, this is not the case for two reasons. First, persons who hold extreme views do not sever their ties to those with opposing views. Homophily is much stronger on other dimensions such as race, gender, and socio-economic status, than it is on political beliefs (McPherson, Smith-Lovin, and Cook 2001, 415-444). Second, persons sometimes do not even know their friends' views on key political issues (Goel, Mason, and Watts 2010, 611) and sometimes actively conceal those that they believe their friends may find disagreeable (Cowan 2013).

Clustering

The full picture of mobilization requires additional measures because it usually takes several individuals to form an effective cell. The other part of this picture is painted by *clustering* which measures the degree to which the radical community is "closely knit" into cohesive cliques that could be the precursors of active terrorist cells. The distinction between low and high clustering can be further seen in Figure 1; boxes A and C represent scenarios where there is very little clustering between the radicals, while boxes B and D represent a scenario where the radicals are highly clustered.

This measure is orthogonal to isolation because being poorly integrated into society does not mean that the person is anti-social and lacks friends. It is often the case that poorly integrated individuals form ties amongst themselves. The nature of terrorist plots demands a level of security-awareness and any prospects have to have a strong level of trust. Therefore such groups tend to be small and contain members who have strong ties to each other, known as cliques or "Bunch of Guys (BOG)" (Sageman 2004; 2008). They can be pre-existent such as in the case of the brothers Tsarnaev, who carried out the Boston Marathon bombings, or formed through an

active search for radicals, such as in the case of the 2005 London Bombers. The literature on radicalization has noted how a cliquish structure further reinforces extreme views among the members and sometimes even shifts them further (see McCauley and Moskalenko 2008, 415-433).

There are multiple ways to measure *clustering*, we use the $\tilde{C}$ metric from Soffer (2005) applied to the subnetwork containing just the radicals. It varies from 0 (lowest) to 1 (highest) and makes important corrections for the degrees of the nodes. Other triad-based metrics could also be used, and indeed, they strongly correlate with $\tilde{C}$, but $\tilde{C}$ includes better adjustment for the number of dyads.

Cell Size

Finally, to measure the sizes of the cells we introduce a metric of *mean cell size* (or just *cell size* for short). Larger cells are more lethal than smaller ones since there is a force multiplier when multiple people are involved and a more devastating attack can be organized, through specialization and division of labor. Figure 1 box E illustrates a network with a low mean cell size; while box F illustrates a high mean cell size (while isolation and clustering are the same).

There is generally a positive relationship between a terrorist organization's size and how many casualties it inflicts (Asal and Rethemeyer 2008, 437-449). Self-starter terrorism tends to be very small relative to conventional terrorist organizations because it is limited to persons who have pre-existing ties such as kin or to highly trusted colleagues. Part of the small size may be limited by design, as larger cells stand a greater risk of being discovered (Gutfraind 2010, e13448). In our dataset of self-starter terrorism, which we used to validate our agent-based model, the average cell size was 2.1 with a standard deviation of 1.9, though this varies

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depending on ideology with Islamist and Extreme Right-Wing cells tending to be slightly smaller than Extreme Environmentalist cells (mean cell sizes 2.0, 1.4 vs. 3.2 respectively). See Appendix C.

We have also considered alternative measures of clustering and isolation which were highly correlated to the metrics we selected and did not change the analysis. Furthermore, in the simulations the three network metrics show a very low correlation among themselves (see Table 1).

Table 1 : Correlation Between the Three Network Metrics of Mobilization in the Simulation Data.			
	Isolation	**Cohesion**	**Mean Cell Size**
Isolation	1		
Cohesion	0.0416 (0.0013)	1	
Mean Cell Size	0.0264 (0.0408)	-0.0617 (0.0000)	1
Notes: Standard errors are shown in parentheses. The table shows that the metrics are largely independent.			

These measures provide information about the state of the artificial society at a particular point in time. In a dynamic society or a social simulation, the values of the metrics change over time as ties form and break. In computing the measures in this dynamic context, we therefore averaged them over the course of the simulations[40].

Network Mobilization Readiness: The Four Scenarios

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[40] As is common practice with simulation work, the averaging began after a burn-in period of 500 tics to allow the system time to settle into an equilibrium state.

Using these metrics one can characterize a network's mobilization readiness, expressed in four mobilization scenarios. This is summarized in Table 2. Each scenario is populated by certain kinds of radical formations and is associated with specific kinds of attacks. The four scenarios do not form an exhaustive list of all possible formations, and we selected them as ideal types by extrapolating from empirical cases of self-starter terrorism. Of the four types, two of the scenarios can be termed scenarios of incomplete mobilization because they have reduced isolation, and so are much less likely to lead to attacks. Importantly, the risk from the scenarios is expressed relative to each other because most self-starter cells fail due to lack of commitment or interception by the authorities. The absolute likelihood of attack is hard to determine: this would require empirical research which we suggest for future work in the conclusion.

Table 2: Definitions of the Mobilization Scenarios.			
Scenario	**Isolation**	**Cohesion**	**Mean Cell Size**
Lone Wolves	Top 50%	Bottom 50%	Bottom 50%
Wolf Packs	Top 50%	Top 50%	Top 50%
Trapped Wolves	Bottom 50%	Bottom 50%	Bottom 50%
Trapped Wolf Packs	Bottom 50%	Bottom 50%	Top 50%
Notes: The percentiles refer to the simulation data.			

The *Lone Wolves* scenario is populated by radical individuals organized into small cells that are highly isolated from the rest of society. They are not embedded in groups of like-minded individuals, and have very few associates of any kind. They may correspond to individuals such as Anders Breivik, Timothy McVeigh, or Eric Rudolph. In terms of our metrics, a network likely to produce such lone wolves is likely to be characterized by high isolation, low clustering, and a low cell size. In this scenario, the bulk of the terrorism risk comes from Lone Wolves rather than larger formations.

The *Wolf Packs* scenario is populated by radicals who form large, internally-clustered

cells that are isolated from the rest of society. Wolf packs enjoy the typical benefits of collective action, perhaps producing some cells that are able to execute relatively sophisticated, high-casualty attacks that are unfeasible if each radical operated alone. They correspond to cells such as the 7/7 bombers as well as the Madrid and Hofstad groups (see House of Commons 2006; Hulst 2006).In terms of our metrics, a network likely to produce wolf packs is likely to be characterized by high isolation, high clustering, and a large cell size.

The *Trapped Wolves* scenario is populated by lone radicals who are embedded in a network of non-radicals. They may be individuals who hold radical beliefs and perhaps even contemplated violent action, but who have a dense network of friends indifferent to radical ideology or actively opposing it. These could be relatives or dependents that impose familial obligations on the radicals. For example the typical trapped wolf/radical may wish to act out his beliefs but it would mean making his family destitute and bringing shame on his kin. Thus, the mobilization is incomplete, and is unlikely to lead to violence. The claim is probabilistic: a trapped wolf may still "escape" but this escape will be less likely under conditions of being embedded. In terms of our metrics, a network likely to produce wolf packs is likely to be characterized by high by low isolation, low clustering, and a low cell size.

The *Trapped Wolf Packs* scenario is populated by radical groups who are embedded in a network of non-radicals. This is likely the most common empirical scenario for Islamist groups in Western countries today. As discussed earlier, we know from polling data that there are very large numbers of persons who hold highly extreme beliefs; some of whom coalesce into groups. But what prevents them from acting on those beliefs? A likely explanation is a dense network of ties and obligations to other members of their community who are not radicals: either co-workers, friends, family members, significant others, neighbors, and community leaders. In

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terms of our metrics, a network likely to produce wolf packs is likely to be characterized by low isolation, high clustering, and a large cell size.

Defanging the Wolves: Mobilization-Preventing Mechanisms

When radicals are a dispersed minority, mobilization is most likely to be prevented because of dynamic network mechanisms that have a counterveiling force of decreasing isolation and clustering and trapping and re-trapping persons with extreme views in circles of non-radicals. There are two such *a priori* mechanisms by which mobilization could be prevented: *encapsulation* and *occlusion*. Encapsulation involves the reduction of isolation while occlusion involves the reduction of clustering between radicals. Both mechanisms exploit one of the most powerful parameters constraining human networks, which is the degree budget. A well-established finding in social network analysis is a limit on how many strong friendships an individual might have (Dunbar 2010). If those slots are filled up, certain other friendships are prevented from forming.

Encapsulation occurs when the degree budget of the radicals is filled up with non-radicals, which prevents isolation. Non-radicals bind to radicals because radical beliefs are not the only basis on which persons form ties – other attributes, such as family background, hobbies and the workplace may also be salient factors upon which friendship is formed. Therefore some individuals holding radical beliefs are (possibly unbeknownst to themselves) trapped in a web of non-radical friends. As we shall see certain aspects of the network ecology systematically facilitate such traps.

Occlusion is facilitated when non-radicals[41] fill up the degree budget of a potential radical and prevent triad closure from obtaining. This process is illustrated in Figure 2. Let us assume that each node has a degree budget of two. Ordinarily, C might form a tie with B, but because C has a strong tie with U, he does not form the tie with B[42].
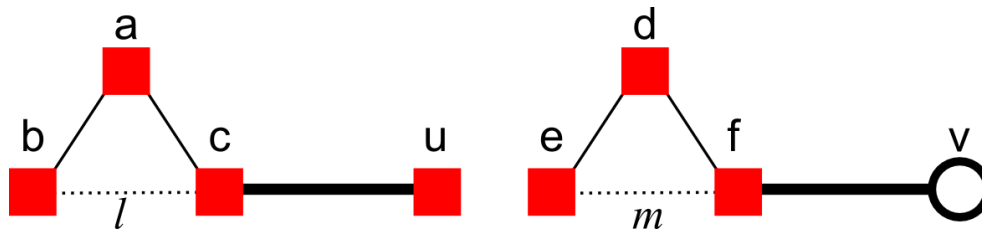
Figure 2. The Occlusion Process. The radicals *a,b,c* fail to form a clustered cell (edge l is missing), as may be expected from the triad closure process, because of a strong tie outside the cell between node *c* and node *u*. Node *c* has a tie to a radical (node *u*), which may have formed through an encounter in a radical magnet. A similar process disrupts a triad of *d,e,f* because of *f*'s tie to a non-radical (node v).

Encapsulation and occlusion play a critical role in preventing mobilization from occurring and illustrate how network ecology may be the invisible hand that explains why we see so much fewer self-starter plots than the numbers of radicals alone would suggest.

Methodology

The Agent-based Modeling Approach

Terrorist cell formation can be investigated using a variety of methodologies, each having a set of strengths and weaknesses. Traditionally, this question has been addressed through

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[41] The process can also theoretically occur with radicals. A radical from a different cluster/cell may occupy the degree budget of another radical preventing triadic closure.

[42] Most people have a degree budget higher than two; this example is meant as the simplest illustration of the process.

interviews of captured members regarding how they met one another. This methodology can provide a wealth of important information, but it also has limitations. Most crucially, it preferentially samples successful rather than failed attacks, and indeed tells us little about radicals that did not mobilize.

Here we employ yet another research strategy – one of using empirically-based computer simulations. Simulation methods make it possible to describe microscopic processes in great detail and then to observe their macroscopic effects (Macy and Willer 2002). Therefore, simulation methods should be very fruitful in studying how radical groups self-organize. Furthermore, by creating artificial societies one can systematically manipulate the parameters of interest to discern meaningful relationships and isolate factors that will be influential over the long-term.

There is no data, as of yet, that would allow us to test our model in a decisive empirical manner. Part of the reason for this has to do with the fact that data on network and ecological variables is expensive and difficult to collect. Nevertheless, we were able to partially validate the model by systematically building a dataset of self-starter terrorism (Appendix C).

The use of agent-based models to study terrorism is not new: similar works include the Civil Violence Model (Epstein 2002), the Threat Anticipation Model (MacKerrow 2003), NetBreaker (North, Macal, and Vos 2004), Seldon (Berry et al. 2004) among others (Rousseau and van der Veen 2005, 686-712; Hammond and Axelrod 2006, 926-936). Our model is different in several respects, most importantly in its use of the Hopfield network (Hopfield 1982, 2554-2558; Hopfield 1984, 3088-3092; Macy et al. 2003, 162-173; Nowak and Vallacher 1998, 277–311) and its focus on the formation of cells primarily around *existing* radicals. The model is also one of the only fully disclosed, open-source code models in the radicalization literature.

Mechanisms Underlying the Agent-Based Model:

Our model simulates a community of *N* individuals, including radicals and non-radicals. Individuals are free to form friendships which are organized into a large social network that includes radical cells as subnetworks. Each individual has a number of fixed binary attributes (+1 or -1), e.g. gender, and variable attributes that could be influenced by peer pressure. The susceptibility to peer pressure is controlled by the parameter *pressurability.*

Upon entering the society (week 0) an agent is enrolled into social venues termed magnets[43].On each subsequent week, this individual/ego has a certain probability of visiting the magnets he/she is enrolled in and thus has a certain probability of meeting one random prospective friend/alter, who is also attending that magnet. The parameter *fraction exposed to magnets (FEM)* indicates the fraction of the population that attends a given magnet, while the parameter *magnetic encounter rate (MER)* is the probability per visit with which an individual would be introduced to another attendee. In practical terms, the exposure parameter may correspond to the unemployment rate: under conditions of high unemployment, magnets of all types are likely to see greater attendance because individuals would tend to have more time to pursue their interests. The encounter parameter characterizes the willingness of people to try new friendships.

To examine in detail the role of magnets on mobilization, we introduced three types of

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[43] Note that magnets bear some resemblance to foci (Feld 1982). Foci are elements of the social structure that channel association along specific traits resulting in homophily (workplace, neighborhood, city). However, not all foci are magnets. The key property of a magnet is that it has the potential of re-wiring ties. Certain foci may "bring homogenous sets of people together" (Feld 1982) but not really change the ties (e.g. neighborhoods, families); instead stabilizing and actually keeping them from being rewired. Second, foci seem to require a pre-existing attribute that organizes people, but such an attribute is not required from magnets. For example, neutral magnets may organize interaction by pure chance (e.g. change meeting at a neighborhood grocery store or a festival). In our conception, a person could visit a neutral magnet based on a kind of focal point strategic reasoning (a la Shelling) or purely out of accidental causes e.g. spontaneous desire for entertainment.

magnets: 1) *radical magnets* that attract only individuals with extreme views such as mosques

led by radical clerics, informal radical seminaries, bookshops and video stores specializing in

fundamentalist material; 2) *neutral magnets*, which are locations that attract individuals without

distinction of political views such as athletic clubs, pubs, or social centers; 3) *pacifist magnets* –

a social site that only attracts pacifists. Indeed, there are a number of organizations that promote

coexistence but are unlikely to attract radicals or uncommitted moderates. We included them in

order to consider the effectiveness of pacifist sites as counter-radicalizing factors.

The rules governing tie formation are based on the Hopfield network. Tie strength varies

continuously in the interval 0 to 1: 0 represents a vanishingly weak tie and +1 represents the

closest friendship. The total number of strong ties a person has is bounded by her degree

budget(see Marsden (1987, 122-131))[44]. The typical budget is around 5 strong ties. Unlike other

Hopfield models, in order to simplify the model and metrics of NMR, we did not allow ties of

repulsion, *i.e.* ties of negative strength[45]. Ties form either through encounters at magnets or

through triadic closure – introduction by a mutual friend (see Davis 1970).

The choice of relationships is based on homophily - the process where individuals with

common attributes are more likely to form ties. (McPherson, Smith-Lovin, and Cook 2001, 415-

444). Thus, a friendship of individuals X and Y is formed only if the average similarity in all of

their attributes is positive. Because of the degree budget, each of the potential friends must either

have (a) a free degree or (b) a friend who is less agreeable[46]. In this latter case, the ego drops this

least-agreeable existing friend/alter in favor of the new alter as expected via homophily.

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[44] McPherson et al (2006, 353-375)finds somewhat lower numbers, while studies relying on online social networks
or other digital information sources tend to show larger numbers.

[45] Indeed, rather than assuming that all agents are connected to each other (Macy et al. 2003), we explore the
connection-forming process in detail. In our simulation, new connections form as a result of either magnets or
introductions by friends.

[46] Old friends/alters receive a bonus based on the longevity of the tie.

Mobilization occurs when radicals form ties among each other. Because two radicals have a shared *zeal* they have a slight preference to form a relationship. A radical is freely able to friend a non-radical and indeed does so if the non-radical is more homophilous than existing radical friends. Zeal is modeled as a variable attributes with states +1 (radical), 0 (moderate), and -1 (pacifist). The totality of relationships involving radicals is measured in the NMR.

During the simulation, the states of the variable attributes and zeal are affected by peer pressure. We closely follow other simulations that use the Hopfield-network and assume that the agents find the average state of their friends, and move closer to that average. For a more technical and thorough understanding of the agent-based model, please see Appendix B.

In addition to magnets, the mobilization of radicals into cells is influenced by both factors and processes intrinsic to the network, and extrinsic factors such as magnets which are called the ecology of the community. The model is composed of three kinds of parameters: individual, structural, and network-ecological factors. Individual parameters refer to traits on the node-level such as the number of traits that individuals possess. Structural factors refer to population-level characteristics such as the size of the population, the extent to which the population is already radicalized, and the extent to which the population experiences attrition. Network ecological factors include local network metrics such the average number of associates a person has, whether those associates know one another, and social sites that rewire the ties between the people in the ecology. Each type of parameter has some influence on how the individuals form ties and contribute to each scenario. We are particularly interested in the network ecological parameters, with a particular focus on the role of magnets. The other parameters can be thought of as control parameters. A more thorough description of the other parameters and how they work is found in Appendix A. In order to facilitate critical review and further development, we

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have made the software and simulation data available online[47]. The source code is freely

available for download and modification. It is based on the free open-source Repast 3.0 Toolkit

(North, Collier, and Vos 2006).

Statistical Analysis

In order to identify the most sensitive social parameters for each mobilization scenario,

we generated 6,000 different simulated societies. Each society was created based on parameter

values that were sampled from parameter distributions.[48] The samples were then created using

the efficient Latin Hypercube Sampling technique (McKay, Beckman, and Conover 1979, 239-

245; McKay 1992, 564; Kleijnen 2008). This is an advance is simulation analysis since it allows

the analyst to sample the entire parameter space rather than focus on a few combinations of

parameter values, which may bias the results.

To measure the effect of any parameter q on mobilization we conducted a sensitivity

analysis (Hamby 1994, 135-154). We compared two distributions: distribution D' for the values

of q in simulations that achieved a particular scenario (e.g. *Lone Wolves*), and distribution D for

the rest of the simulations. The difference in the means of q was standardized, and the

distributions compared using the Mann-Whitney test. A large and significant difference implies

that q contributes to a given scenario (ibid)[49].

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[47] The software is available from my website http://people.soc.cornell.edu/mg324/replication-data.html. The replication section also contains documentation, release notes, and the raw simulation output as well as batch files.
[48] Interested readers may consult the attached simulations data to examine the parameter space we used. The population size has a mean of 20000 and standard deviation of 10000, and is truncated to lie in 1000-100000. Other parameters were sampled from similarly large ranges to capture uncertainty, while consistent with plausible values for a developed country.
[49] In addition to the distribution analysis we examined sensitivity using other techniques. In particular, we fitted rank order regression models and quantile regression models. The most sensitive parameters were identified consistently. The above D-D' technique was chosen since it is most robust to non-linearity and heteroscedasticity.

Findings

Unleashing the Wolves: Complete and Incomplete Mobilization

The data suggests a systematic importance of certain parameters in the production of the four scenarios. While some of the results are consistent with expectation, others are somewhat counterintuitive (in respect to both the positive and negative findings). Greater attention will be paid to the latter type of results. Only statistically significant parameters as well as effect sizes close to or above 0.2 will be discussed. The complete summary of the simulation results are shown in Figures 3 and 4. While Figure 3 shows the effects of the parameters on individual metrics of mobilization, Figure 4 shows the effects on each of the four scenarios.
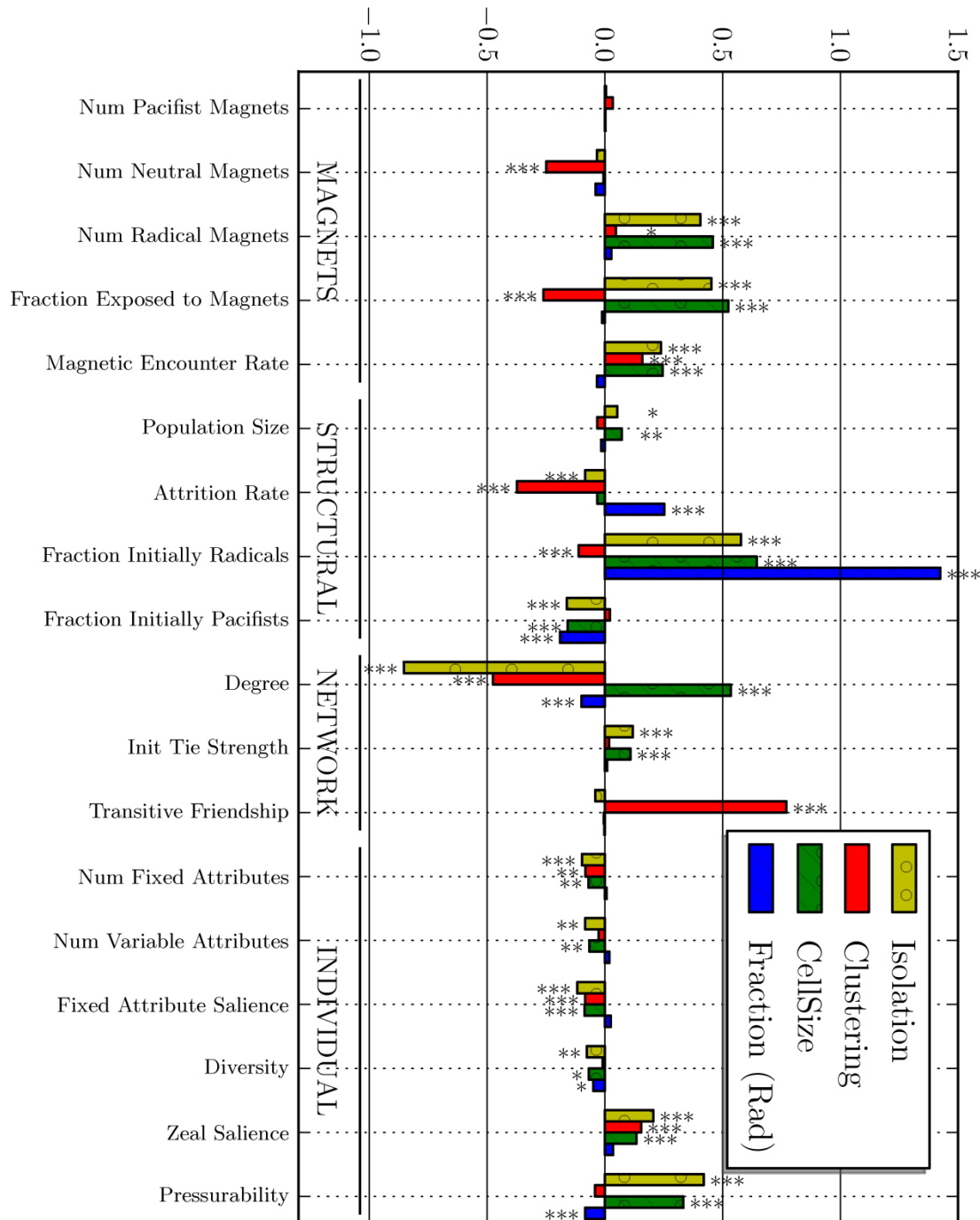
Figure 3. The Effects of the Model Parameters on the Measures of Mobilization. The four series represent each of the four measures that were in the top 50% of the simulations. For each parameter, a bar indicates the difference in the mean value of the parameter (mean over the top 50% – the mean in the full set) standardized by the standard deviation in the full set. Significance is based on the Mann-Whitney test (*<0.05, **<0.01, and ***<0.001).
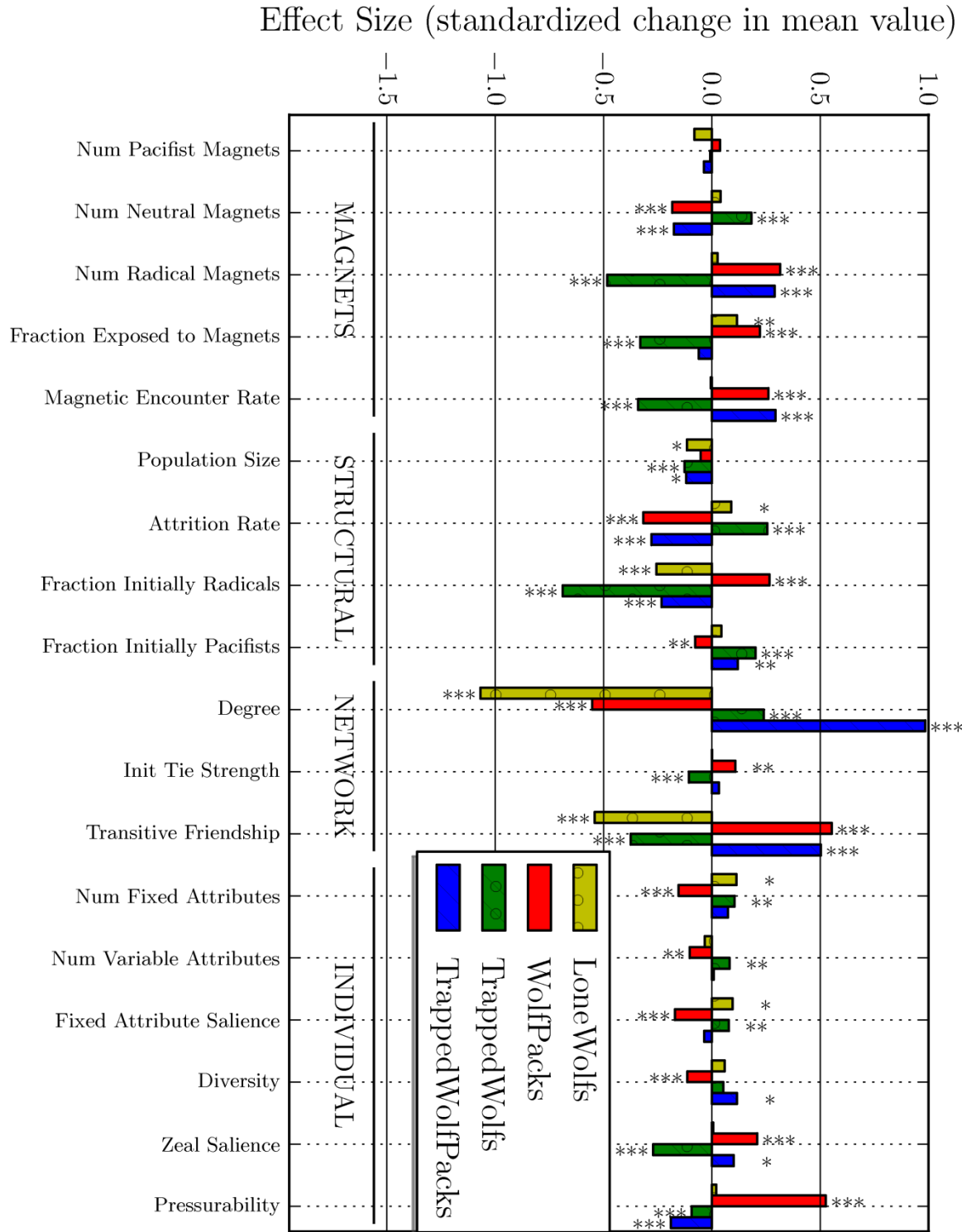
Figure 4. Parameter-Scenario Sensitivity Analysis. For each parameter, the bar indicates its importance to the scenario. For each parameter, a bar indicates the difference in the mean value of the parameter standardized by the standard deviation in the full set. Significance is based on the Mann-Whitney test (*<0.05, **<0.01, and ***<0.001).

Lone Wolves

The key parameters associated with creating Lone Wolves are fraction of initial radicals, average degree, and transitivity. The fraction of initially radicals is negatively related to Lone Wolves because in a larger radical subpopulation, Lone Wolves are more likely to coalesce into Wolf Packs. Average degree ("Degree" in Figures 3 and 4) has a strong negative relationship to Lone Wolves, since degree facilitates association with radicals, creating wolfpacks, and non-radicals, creating trapped wolves. A similar logic applies to transitivity. Surprisingly not all types of magnets contributed to the scenario. One might have imagined that radical magnets would create bonds between isolated radicals (a negative effect on Lone Wolves). However, magnets are not able to surmount the basic social conditions that lead to Lone Wolves: a small radical population and a low number of ties (degree).

Wolf Packs

The key parameters associated with creating Wolf Packs are radical magnets, fraction exposed to magnets, fraction of initial radicals, transitivity, and pressurability. The role of pressurability is of particular interest. Pressurability controls how easily a node can be "converted" when surrounded by opposite-minded friends. The positive effect of this parameter is counterintuitive because the model did not give any zeal level a stronger appeal than any other trait. Thus, one might expect that it would be the radicals who are overwhelmed by the much larger non-radical population. This de-radicalization does happen (see Fig. 3), but high pressurability also means that radicals can form pockets where they are the majority and where

they can convert some moderates into their viewpoint. In essence, pressurability decreases the quantity, but increases the quality of mobilization.

Increasing the number of neutral magnets, the average degree, or the attrition rate tends to reduce Wolf Packs. Neutral magnets have a negative effect because they introduce radicals to non-radicals, who generally outnumber radicals. The non-radicals occupy the slots on the radical's degree budget thereby reducing isolation (encapsulation) and preventing triadic closure (occlusion). The negative effect of average degree is somewhat surprising, since radical cells themselves require connections to many radicals. While this process does operate, having many friendships also hurts Wolf Packs in two ways. First, the more friends a radical has the more likely one of those friends would be a non-radical, reducing isolation; Second, it becomes more difficult to achieve high clustering.

Attrition (population turnover) facilitates the destruction of all social ties, and has the effect of damaging radical packs and reducing mobilization. Radicals who arrive at the community tend to form ties with non-radicals, who are the majority, at least before they travel the proverbial journey to finding like-minded persons. The effect of *radical attrition rate* was found to be qualitatively similar to the effect of the overall attrition rate.

Trapped Wolves

Broadly speaking, Trapped Wolves are created by the same processes that destroy ties in Wolf Packs or that create ties in Lone Wolves. Magnets play an important role in the trapping of Lone Wolves because their number grows with an increase in neutral magnets, a decrease in radical magnets, and a decrease in the fraction exposed to magnets. Structural parameters too play a large role, perhaps affecting this scenario most. Increasing the fraction of initial radicals

tends to decrease the number of Trapped Wolves. We see this because the availability of more radicals makes larger cells, ultimately creating Wolf Packs and Trapped Wolf Packs.

Network parameters such as average degree exert a positive effect while transitivity exerts a negative effect. Furthermore we see that only one individual factor matters, diversity, and it has a small negative effect. Once again we observe the demobilizing effect of high average degree and neutral magnets as both parameters facilitate a process of radical encapsulation.

Trapped Wolf Packs

To understand how Trapped Wolf Packs are created, recall that they have high cell size, high clustering, and low isolation. The operant mechanism here is occlusion, which prevents clustering. We see that neutral magnets play an especially prominent role in facilitating occlusion. Wolf packs are trapped not because they are introduced to non-radicals but because radicals are prevented from forming transitive ties to other radicals in the first place.

Much like neutral magnets, attrition exerts a negative role through occlusion rather than encapsulation. It decreases clustering by breaking up radical cells hence converting Trapped Wolf Packs to Trapped Wolves. Average degree and transitivity on the other hand operate via encapsulation; they facilitate the surrounding of radical cells by non-radicals. Pressurability exerts a negative effect on trapping radical cells because it allows for the easy conversion of moderates who would otherwise act as encapsulators.

The agent-based model suggests that magnets play a very important role in facilitating and preventing mobilization. Radical magnets exert a significant effect in forging bigger cells. They do so by decreasing encapsulation, isolating the radicals and establishing larger radical formations. Radical magnets thus contribute to both Wolf Packs and Trapped Wolf Packs.

Neutral magnets, on the other hand, have a de-mobilizing effect. Neutral magnets counteract the formation of radical cells through the occlusion process, by inhibiting the clustering among radicals.

Discussion and Conclusion

Our study proposes a new perspective in understanding mobilization into self-starter terrorism. This kind of approach complements studies that examine mobilization from a more motivation-oriented perspective that has been prominent in the literature. While more validation of the model is necessary, it is already clear that mobilization is not a function of radical beliefs alone. The results from the simulations showed that the fraction of radicals in the community was usually independent of the more network-based measures of mobilization, and independent of factors that influenced the network. This underscores the need for measuring self-starter terrorism using metrics that take network information into account.

Therefore, and this might be our most important finding, surveys of extreme opinions should ask questions not only of the radicals but also about the associates of radicals. What are needed are more detailed network questions to better understand the embedding of individuals with radical beliefs. By doing so we can understand what scenario we are truly facing. Consider the question with which 7% of Muslims in Britain agreed "I admire organizations like Al-Qaeda that are prepared to fight against the West" (Mirza, Senthilkumaran, Ja'far 2007). It would be useful to follow up the question with a standard name generator and interpreter questions which ask the person to list his or her associates and then asks for information on each associate provided (See Marsden 1990). The question above may be asked as a measure of radicalization of their associates. A more sophisticated design may snowball sample the associates and pose the

question to them directly. The results may tell us how isolated or clustered the radical individuals are. It may be that most radicals have few family and friends – resembling the lone wolves scenario. The opposite case - that most radicals have many radical friends – would resemble the Wolf Pack scenario. It may also be that the Wolf Packs are trapped, though this will require a more complex sampling design. Tracking the level of mobilization readiness over time in various communities and seeing if it predicts incidents of self-starter terrorism would provide a good test of our theory.

One of most intriguing parameters in the model is that of magnets. While we have treated magnets as being discrete - radical magnets center on a radical trait and neutral magnets center on a neutral trait. It is possible for there to be a type of magnet that is in between, such that the overt purpose of the magnet is neutral, but it happens to attract persons who are disproportionately radical. For example, if holding beliefs in violence is correlated with a fondness for martial arts or paintball, which are neutral magnets in our rubric, these activities will disproportionately attract radicals. While overtly radical magnets may be the most effective tools, they may be the most closely scrutinized and therefore avoided by would-be terrorists. While we found that radical magnets can produce both wolfpacks and trapped wolfpacks, it would be useful to investigate the kind of conditions or interactions with other parameters that make one outcome more likely than another.

While many factors that influence the radicalization of attitudes are difficult to change, factors that affect mobilization, such as increasing the number of neutral magnets, may be more amenable to intervention. An important idea that emerges from this study, that may interest policy-makers, is the concept of "disguised magnets". Authorities may want to sponsor neutral magnets but those neutral magnets would be most effective if they are disguised as radical

magnets so that they can draw in unsuspecting radicals and gradually integrate them with non-radicals. For example, an organization that offers community paintball – a high action type of activity (that may draw in individuals with radical beliefs), which in subtle ways introduces lessons of coexistence by pairing Islamists and moderates (who may or may not be confederates) on the same team. On the other hand radical entrepreneurs may follow the same logic by creating radical magnets disguised as neutral magnets (e.g. the so called "Al Qaeda gym" created by the organizer of the 7/7 cell). Authorities should therefore keep an eye not only on radical magnets but also on neutral ones as well.

The two kinds of new magnets are represented in Table 3, a 2x2 table where the overt purpose of the magnet is crossed with de facto attendance that the magnet attracts. This paper has investigated the diagonal – radical and neutral magnets. However a natural extension is to investigate the effect of the off-diagonal cells – the disguised and correlated magnets.

Table 3: Four Types of Magnets			
		De Facto Attendance of Magnet	
		Radical	Neutral
Overt Purpose of Magnet	Radical	*Radical Magnet*	*Correlated Magnet*
	Neutral	*Disguised Magnet*	*Neutral Magnet.*

Finally, while the results of the ABM are suggestive, it would be useful to identify and measure empirically which variables affect isolation and clustering. One of the more provocative implications of our paper is that seemingly innocuous factors such as recreational and social clubs (neutral magnets) may be critical in holding back violence. There may be other such network ecological factors whose decrease or increase can either prevent or unleash self-starter terrorism. This line of research will have obvious policy implications for reducing the incidence of self-starter terrorism.

Appendices

Appendix A: Model Motivation and Parameters

How do individuals with radical beliefs find one another and form a group to carry out terrorist attacks, in the absence of a pre-existing organization or a coterie of recruiters? What sort of factors and processes are relevant to model this dynamic? We argue that to answer these questions one has to recognize that the way individuals with radical beliefs find one another and form groups is (at least on the most basic level) no different from the way any set of persons with similar beliefs or interests find each other and form groups; be it reading groups, transient social movements, bible study societies, or swingers clubs. And since group formation has been studied quite extensively, it is reasonable to use findings from this literature as the core of our model. We then incorporate features unique to our subject matter - minority populations with clandestine attributes (such as beliefs in violence).

The process of group formation is shaped by three kinds of constraints: *structural*, *individual*, and *network*-related. In the model, each of those constraints is realized by simulation processes, which are in turn controlled by numerical parameters. Thus, we assign the parameters to the three parts of the social ecology: societal parameters (population size, social cleavages, tie-organizing sites), individual parameters (fixed and variable traits of individuals), and network parameters (the size of personal networks, relationship strength, and propensity for transitivity). The names and values of the parameters are summarized in Table I.

Structural Parameters

A sizable literature has called attention to the relationship between the size of human aggregates and various sociological processes (Mayhew and Levinger 1976). Therefore a basic

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structural factor to take into account is population size which we modeled as a single parameter denoting how many agents are interacting. Within a society, the size of social cleavages is considered critical for inter and intra-group relations (Rytina and Morgan 1982). We thus allowed for a distribution of beliefs in political extremism, beliefs which we classified into three categories: radicals, moderates, or pacifists. The parameters *fraction initially radicals* and *fraction initially pacifist* (and implicitly, the fraction initially moderate) controlled the distribution of beliefs in persons entering the population. Those beliefs were then subject to change via peer influence during the course of the simulation[50]. Though, in most simulations, as in reality, few agents actually changed their beliefs during the course of the simulation.

Next, we incorporated the presence of magnets, which are sites and various social venues where people may meet and form friendships. This is one of the most important factors in the model. Indeed, a House of Commons report on the 7/7 Bombers states that "A common factor for all 3 – Khan, Tanweer and Hussain – was the social life around the mosques, youth clubs, gyms and the Islamic bookshop in Beeston." (House of Commons 2006, 15). The report further states that "camping, canoeing, white-water rafting, paintballing and other outward bound type activities are of particular interest because they appear common factors for the July 7th bombers and other cells disrupted previously and since" (ibid, 17). Moreover, Mohammed Bouyeri, Jason Walters and Samir Azzouz of the Hofstad group in the Netherlands met at a phone shop "that was used by a group of young Muslims to pray, watch gory tapes of terrorist actions, and talk about their desire to participate in jihad" (Vidino 2007, 582). It is not surprising that would-be radicals would meet one another through preexisting groups and organizations. This view is also

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[50] While we sampled a range of parameter space, these parameters can be calibrated based on polling data. For example according to one 2006 UK poll "15% of British Muslims agreed that violence against civilians, to defend Islam is sometimes justified" (Pew Research Center 2006, 3).

consistent with the research mobilization literature (Jenkins 1983; McCarthy and Zald 1977). In our terminology, all sites that attract individuals and rewire their social connections by introducing them to new friendships are referred to as *magnets[51]*.

Upon examining case studies of Islamist self-starter cells, there appears to be two types of social sites of where the cell members met: 1) *radical magnets* that attract only individuals with extreme views such as mosques led by radical clerics, informal radical seminaries, bookshops and video stores specializing in fundamentalist material; 2) *neutral magnets*, which are locations that attract individuals without distinction of political views such as athletic clubs, pubs, or social centers. We also included pacifist magnets – a social site that only attracts pacifists. Indeed, there are a number of organizations that promote coexistence[52] but are unlikely to attract radicals or uncommitted moderates. We included them in order to consider the effectiveness of pacifist sites as counter-radicalizing factors.

In modeling magnets we had to specify two additional properties: *fraction exposed to magnets (FEM)* and the *magnetic encounter rate (MER)*. The former indicates the fraction of the population that attends any given magnet. The latter is the probability per visit with which an individual would be introduced to another attendee[53]. In practical terms, the exposure parameter may correspond to the unemployment rate: under conditions of high unemployment, magnets of

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[51] Note that magnets bear some resemblance to foci (Feld 1981). Foci are elements of the social structure that channel association along specific traits resulting in homophily (workplace, neighborhood, city). However, not all foci are magnets. The key property of a magnet is that it has the potential of *re*-wiring ties. Certain foci may "bring homogenous sets of people together" (Feld 1982, 798) but not really change the ties (e.g. neighborhoods, families); instead stabilizing and actually keeping them from being rewired. Second, foci seem to require a pre-existing attribute that organizes people, but such an attribute is not required from magnets. For example, neutral magnets may organize interaction by pure chance (e.g. change meeting at a neighborhood grocery store or a festival). In our conception, a person could visit a neutral magnet based on a kind of focal point strategic reasoning (a la Shelling) or purely out of accidental causes e.g. spontaneous desire for entertainment.
[52] For example the Ansar Youth Project, see http://www.ansaryouth.org.uk/main/
[53] A possible extension of the model would be to allow realistic variation between magnets along those parameters.

all types are likely to see greater attendance because individuals would tend to have more time to pursue their interests. The encounter parameter characterizes the willingness of people to try new friendships.

Finally, an important factor to consider in a model of tie formation is the number of individuals who are leaving and entering the community, the *attrition rate*. We suspected that outmigration may have a little-noted but important disruptive effect on the formation of radical cells. An additional parameter in our model, *radical attrition increment (RAI)*, allowed us to specifically vary the attrition rate of radicals. We believe that their migration rate may be greater than the population as a whole because radical individuals may find themselves maladapted to prosper in their community, and thus may have an increased tendency to migrate away. Another plausible reason to differentiate the attrition rate for radicals from the overall population is that radicals may get arrested if they act on their beliefs.

Individual Parameters

Individuals in our model had two kinds of attributes. First, there are fixed characteristics about a person that cannot be changed easily such as race, gender, nationality, personality, and religion. Second, human beings also have attributes that are variable such as interests, hobbies, and more mundane preferences. The overall variability of attributes in the population is determined by a parameter termed *diversity,* which ranges from 0 (all attributes except zeal are identical across the population) to 0.5 (half the population has one of the values, while the other has the opposite value). A particular kind of variable attribute is political belief in violence, which we call *zeal*. Zeal ranges from *pacifist*, through *moderate* to *radical*, i.e. from opposing to supporting political violence.

While in practice individuals may have hundreds of these characteristics, only some of

them are likely to be socially salient to the formation of ties in a given community. Though, there may be some variability even within the salient parameters. Therefore, the parameters *fixed attribute salience* and *zeal salience* control the weight of the fixed attributes and that of zeal relative to the variable attributes.

Another individual parameter of the model is *pressurability*: the extent to which individuals conform or adopt variable attributes such as opinions from their friends. The higher the pressurability, the more weight individuals put on the average opinion of their friends in the network. For example, under conditions of high pressurability moderates may become radicals if they are surrounded by many radical friends. There are many sources of variation in pressurability; they may range from individual factors such as one's personality to socio-cultural factors such as collectivism-individualism[54].

Network Parameters

Each person has a degree budget, the maximal amount of friends they can have. Marsden (1987) identified the social networks of Americans from the General Social Survey at a maximum of 5, the average of kin members at 1.5, and that of non-kin at 1.4 persons[55]. New ties are formed during the course of the simulation, but once the total number of ties reaches an individual's degree budget, no more are formed or the weakest one is dropped. Another important network process is triadic closure – the formation of ties between individuals that share friends (see Davis 1970). On the societal level one can think of this as the propensity to form close-knit communities even among strangers. This propensity may vary from society to

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[54] Individualistic societies may be characterized as having relatively low pressurability and conformity, compared to collectivist societies (Bond and Smith 1996).
[55] McPherson et al (2006) finds somewhat lower numbers, while studies relying on online social networks or other digital information sources tend to show larger numbers.

society and so we controlled this process by the parameter of *transitivity*. Finally, the strength of

newly-formed ties may reflect the trust of strangers in a society, and is governed by the

parameter *average initial tie strength*. The full listing of the parameters is found in Table I,

which also gives their default values and ranges as used in the sensitivity analysis.

Table I: Complete Listing of the Model Parameters

	Parameter	**Default value**	**Range**
Structural	*Population size*	10000	1000-50000
	Attrition Rate	0.1	0-0.2
	RadicalsAttritionIncrement	0.03	-0.05 – +0.05
	NumMagnets – Neutral	100	0-200
	NumMagnets – Radical	25	0-50
	NumMagnets – Pacifist	25	0-50
	MagneticEncounterRate	0.2	0-1
	FractionExposedToMagnets	0.03	0.0-0.1
Individual	*AvgPressurability*	0.33	0-1
	FractionInitRadicals	0.05	0-0.5
	FractionInitPacifists	0.05	0-0.5
	NumFixedAttributes	5	0-9
	NumVarAttributes	7	0-12
	Diversity	0.25	0-0.5
	FixedAttribSalience	2	0-12
	ZealSalience	2	0-10
Network	*AvgDegree*	5	0-30
	Transitivity	0.1	0-1.0
	AvgInitTieStrength	0.1	0-1.0
	LinkAgeBonusFactor	100	0.1-500
	MaxLinkAgeBonus	1.0	0-3
Others*	*RunLength**	1000 tics	Fixed
	NumZealLevels*	3	Fixed
	DegreeSD*	1	0-10
	InitTieStrengthSD*	0.05	0-1
	PressurabilitySD*	0.1	0-1
	StrengthUpdateRate*	0.2	0-1
	SwitchRandomness*	0.1	0-0.5
	SwitchPressFactor*	10	0.5-100

Note: Parameters indicated by * are not explained in the text.

Appendix B: Model Dynamical Equations

In this part, we briefly describe the fundamental dynamical equations governing the model. Even a simple model such as this can be programmed in slightly different ways, and for completeness, we have provided the full source code at our website, alongside the Java executable. In most features, this discussion follows Macy et al. (2003).

The state of a simulation at time t is described by knowing three pieces of information: the states of the agents A, the strengths of the ties between the agents T, and the membership of the magnets M. Thus,

- A_i^a indicates the state of attribute *a* of agent *i*. For all attributes except zeal, the possible values are -1, 1. For the case of zeal, the additional value of 0 represents the moderates.

- T_{ij} gives the strength of the tie between agents *i* and *j,* taking values in the interval [0,1]. If no tie exists, then the value is 0. Negative-weight ties (antagonistic relationships) are not considered.

- M_i^m equals 1 if agent *i* visits magnet *m,* and 0 otherwise.

We use the convention that a subscript always indicates an agent.

In variable attributes, agents have a propensity to adopt the average state of their neighbors, where the propensity is a logistic function of the pressure. The social pressure on agent i at attribute a, is given by the equation:

$$
\begin{aligned}
P_i^a &= \frac{\text{tie-weighted states of neighbors of } i}{\text{number of agents tied to } i} \\
&= \frac{\sum_j T_{ij} A_j^a}{\sum_j \lceil |T_{ij}| \rceil}
\end{aligned}
\tag{1}
$$

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The agent would change its state if:

$$\frac{1}{1 + \exp(-10|P_i^a|)} \cdot PP > 0.5 + 0.1 \cdot x \tag{2}$$

where PP is the "peer pressurability" of the node (explained next), and x is a uniform random number in [-1,1]. We introduce x to make the nodes randomly change states near the threshold pressure. PP is determined at the time of node's creation by randomly generating a number from a uniform distribution centered at the population-wide *AvgPressurability*. Eqn.2 and other dynamical equations involve preset constants. Because these constants have little social meaning, or are not expected to affect the simulation materially, we did not expose them to the user of the simulation, but they are reported in Table I for completeness.

The effect of peer pressure on zeal is governed by an identical equation, except that the state of the node moves in steps towards the peer average. Crucially, we assume that the pressure experiences by moderates (zeal=0) is the same as by radicals (zeal=+1) and pacifists (zeal=-1). For fixed attributes such as ethnicity peer pressure has no effect.

After the variable attributes have been updated, the strengths of the ties T_{ij} are also updated. If T_{ij} is the current strength of the tie, then at the next tic, the strength would be:

$$T'_{ij} = 0.8 \cdot T_{ij} + \frac{0.2}{K} \sum_{a=1}^{K} A_i^a A_j^a \tag{3}$$

where K is the total number of attributes (fixed + variable + 1, where 1 is the zeal attribute). The summation formula implies that the ultimate tie strength would reflect the net agreement

between the attributes of the nodes, because at that point $T_{ij} = T'_{ij}$. If the absolute strength of a tie falls below 0.01 it is disconnected. Also, notice that because at equilibrium tie strengths would be a symmetric function of the states of the agents, the two ties would have the same strength, that is $T_{ij} = T_{ji}$.

During the tie-formation process, the agreement between the putative friends i and j is computed by summing the products $A_i^a A_j^a$ and weighing them. The weight of fixed attributes and zeal is multiplied by parameters *FixedAttribSalience* and *ZealSalience* respectively. Additionally, since older friendships are more durable, we introduce a bonus term for relationships based on their longevity. Specifically, the agreement is increased at a rate of 1/*LinkAgeBonusFactor,* up to a value given by *MaxLinkAgeBonus*. For example, if *MaxLinkAgeBonus*=1, then a very long lived friendship will receive a bonus comparable to having one variable attribute in common.

Unlike previous work in Hopfield networks, our model introduces the important notion of magnets. Indeed, rather than assuming that all agents are connected to each other (cf. Macy et al. 2003), we explore the connection-forming process in detail. In our simulation, new connections form as a result of either magnets or introductions by a friend. That said, membership in a magnet *can* be viewed from a Hopfield perspective as an additional attribute of nodes. Like other attributes, we assume that upon joining the society, each node explores the magnets and decides which ones to attend. Thus, it carries with it attributes that specify its membership in magnets. Yet, unlike regular attributes which affect the strengths of existing ties, that type of attributes affects the very potential for new ties.

As expected from a Hopfield-network-based model, our model exhibits behavior characteristic of such models. This includes: 1) A short period of relaxation into a local potential

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energy minimum at the beginning of a simulation run; 2) Increasing the number of individuals, the number and strength of ties, as well as the number of attributes leads to the model reaching lower energy states.

Appendix C: A Partial Empirical Validation of the Model

The validity of a model depends on the extent to which its predictions correspond to empirical reality. While it is not possible to carry out this type of validation for every model prediction, particularly in respect to measures of clustering and isolation (data on the levels of clustering and isolation of radicals are very hard to collect), it is possible to obtain empirical data in respect to the measure of average cell size. We therefore collected data on cases of self-started terrorism in the United States and Western Europe from January 1990 through March 2010. Databases such as Lexis-Nexis as well as various lists[56] and datasets[57] were combed for cases of self-starter terrorism. Coders were instructed identify a terrorist cell as self-starter if the following conditions were met: 1) its members are not part (or have not been part of) a professional terrorist organization (PTO); 2) it has not received assistance (e.g. financial, training, or logistical) from a PTO; and 3) it has not received commands/instructions from a PTO. A PTO is defined as a terrorist organization that existed and was active for more than three years, had more than ten members, and engaged in more than three attacks that resulted in casualties or physical damage. The final dataset that we compiled contained 110 cells, ranging from 1 to 13 individuals (237 persons in total) and involved three types of radical movements: Islamic extremism, Environmentalist extremism, and various Right-Wing extremism (e.g. anti-government, hate-crime, anti-abortion)[58]. These movements are the key practitioners of leaderless resistances contrasted to the more traditional organizational/pyramidal terrorism.

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[56] Southern Poverty Law Center, FBI Chronology of Domestic Terrorism, Anti-Defamation League as well as other sources were used to compile a list of cases.

[57] The datasets we used were compiled by Alan Krueger (2008), Steven Brooke and Robert Leiken (2006), American Terrorism Study (TRC 2010), and the Global Terrorism Database (START 2010).

[58] There were a few rare cases of entrapment or plea deals where judgment calls had to be made regarding inclusion. Space limitations in the paper do not allow us to discuss all the criteria used. Interested readers should contact the authors for details.
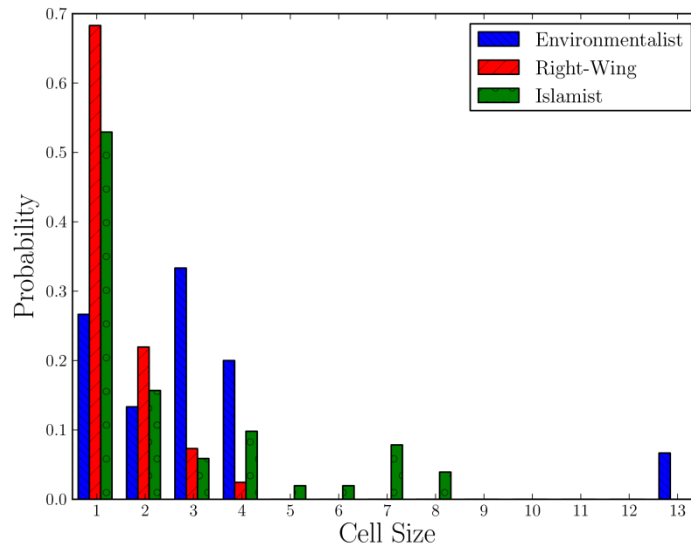
Figure 5. The Empirical Distribution of Cell Sizes. Right-Wing cells tend to be small compared to Islamist and especially Envonmentalist cells.

The average cell size data on those groups is summarized in Figure 5. The figure suggests that Islamist and Right-Wing cells tend to be smaller than the Environmentalist cells (mean cell sizes 2.0, 1.4 vs. 3.2 respectively). The distributions of Right-Wing and Environmentalist cells are significantly different on the Kolmogorov-Smirnov (KS) test ($p<0.01$) but other pairs show no statistically significant difference ($p>0.05$). The KS test was used because it is more robust on small sample sizes. The Mann-Whitney test was in agreement but also identified a significant difference between Right-Wing and Islamist cells ($p<0.05$). This data was then compared to the predictions generated by the simulations. The goal was to determine whether the average size of the simulated cells approximated the size of the cells observed in the empirical data[59]. Figure 6

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[59] It is important to recall that "radicals" are defined quite broadly in the simulations - as essentially anyone with a high zeal level, regardless of their involvement in violent activities. Clearly only a fraction of such radicals act on their beliefs and become violent. Hence this comparison is possible only to the extent that the shift to actual violence does not depend on the size of the grouping in a significant way.

shows the empirical and predicted distribution of cell sizes. Visually the simulated data shows

fewer 1-person cells and more 2-person cells compared to the empirical values, but otherwise

they are quite similar. Indeed, the Kolmogorov-Smirnov two-sample test has a p=0.49,

suggesting that the distributions are not significantly different (similarly, p=0.46 on the Mann-

Whitney test). To compute the difference between the distributions, we computed the Hellinger

distance score, H (Torgersen 1991). In general, H ranges from 0 to 1; in this case H = 0.05,

suggesting that the distributions are very close. We also made sure that the result was not a built-

in artifact of our estimate for the distribution of average degree: the correlation coefficient of

average degree with the mean cell size was only 14%.
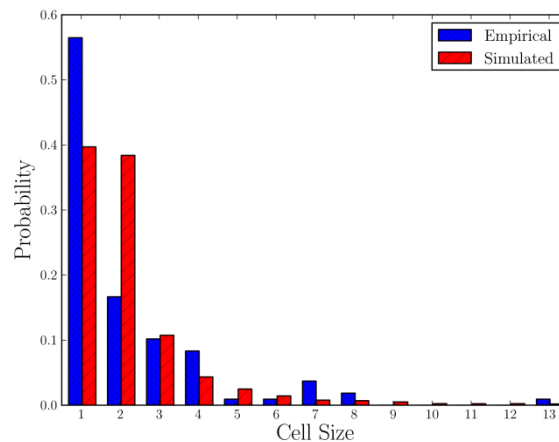
Figure 6. The Distribution of Cell Sizes in the Simulation and Empirical Data. The distributions are statistically indistinguishable, giving important validation to the model. Bin 13 contains all cells of size 13 or more.

The correspondence between the empirical and predicted distributions shows that the

model is capturing aspects of reality. Intriguingly, it offers suggestive explanations of specific

patterns in the sizes of cells between the three types of self-starter groups in our dataset.

Consider Figure 5 where environmentalist groups tend to form larger cells akin to Wolf Packs,

while Islamist and rightwing groups tend to form Lone Wolfs. One explanation is that Islamist groups are often composed of immigrants or their children who lack dense social networks that, by contrast, may characterize activists who makeup environmentalist groups. Right-wing groups who are anti-government may be more anti-society generally and more suspicious of large collectivities. They are less likely than other types of radicals to frequent magnets and even less likely than Islamists to have dense social networks; some right-wing terrorists pride themselves on being independent individualists and hence would probably eschew having many friends.

Members of environmentalist movements display the opposite trend, that of being embedded in the broader community and connected to its institutions. This is partly the reason why those groups tend to focus on property damage rather than on injuring or killing, leading to greater societal acceptance of such actions as well as greater support (in our model, greater fraction of initial radicals). Furthermore, because moderate environmentalism is widely accepted in the United States and Western Europe, extreme environmentalist groups may be able to form and maintain radical magnets with greater ease.

Cell size is also determined by certain tactical requirements. Since environmentalists tend to engage in operations that focus on damaging property, their cells require more people to be effective. In contrast, right-wing Lone Wolfs tend to focus on operations involving firearms and explosives, which do not require such large cells to organize and carry out. A single terrorist wielding a gun can cause many fatalities, while many more people are needed to coordinate and execute a sabotage campaign[60].

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[60] We acknowledge that these explanations of difference in cell size of the three self-starter radicalization movements is partly speculative and a more exhaustive study would need to be conducted to conclusively pin down the cause for the size variation.

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CHAPTER 3: THE ORGANIZATIONAL ECOLOGY AND RECRUITMENT INTO VIOLENCE: A BLAU STATUS ANALYSIS

The modern type of group formation makes it possible for the isolated individual to become a member in whatever number of groups he chooses. Many consequences resulted from this. Georg Simmel (1922) from Die Kreuzung Sozialer Kreise "The Web of Group Affiliations[61]"

The final ecological approach considers the role of organizational affiliations in affecting engagement in political violence. This chapter is composed of three parts. First it introduces a unique framework of how organizational competition can be modelled to explain individual behavior, termed Blau Status Analysis (BSA)[62]. The second part is much more narrowly focused with an eye to validating the approach on an empirical dataset. Specifically, it shows how certain kinds of Blau statuses are useful in explaining important aspects of social network topology. The third part applies BSA to explaining the recruitment of persons into covert networks and discusses the approach's relevance to terrorism and political violence.

PART I: WHAT IS BLAU STATUS ANALYSIS?

Echoing Simmel's insight modern humans find themselves entangled in a web of group affiliations. From hospitals to nursing homes, from schools to workplaces, from Boy Scouts to Elks, from the cradle to the grave, modern industrial societies are permeated with organizations of every stripe. The average American today exists in an environment saturated with associations large and small, instrumental and normative, open and closed. One of the most important dynamics characterizing this organizational proliferation is competition. Organizational competition occurs over customers, clients, employees, and members. It is well recognized that

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[61] Literal German translation is "Intersection of Social Circles". Web of Group Affiliation was the more evocative translation coined by Reinhard Bendix (1964)

[62] I have spent three years developing this method with colleagues (Brashears, Genkin, and Suh Under Review).

organizations exert all sorts of effects on their members such as socializing members with particular norms and attitudes (Bauer, Morrison, and Callister 1998; Cooper-Thomas and Anderson 2002). But does organizational proliferation and competition exert an effect on non-members who exist in an environment of such competition? We argue that people located in an environment where there are lots of competing groups will be affected by this competition, irrespective of their membership in those groups. In particular their position in the competitive ecology will affect their networks as well as the kinds of behaviors they engage in and the attitudes they hold.   This paper argues that this organizational ecology is an important, but often neglected part of the social structure, when it comes to analyzing individual behavior. We proceed to offer a theoretical and methodological framework for conducting such an analysis, arguing that organizational competition sorts the competed-over persons into certain kinds of statuses, which we call Blau Statuses. The paper then shows how these Blau Statuses systematically affect both network dynamics as well as conventional outcomes of interest to sociologists.   We do so using two datasets that contain both association and affiliation data and most importantly contain multiple ecological units (different schools, different communities) that differ in their configuration of Blau Statuses.

One of the most fundamental insights of network analysis is that human behavior should not be analyzed in isolation from other actors. Instead human beings form networks and these networks exert a profound influence on the actors that are embedded within them. Human beings not only form networks but organize into groups and complex organizations. Indeed almost any complex social system from a high school to a city enjoys a myriad of groups and associations. A very important dynamic is that these organizations compete with one another for members. This competition sorts individuals into certain kinds of positions, thereby creating an underexplored

layer of social structure. This paper suggests a framework for thinking about these positions, which we call Blau Statuses. We present evidence that these positions explain certain kinds of network properties and exert an independent causal force on certain individual behaviors.

Social network analysis usually takes network properties as a given to explain other social properties. It has generally been recognized that network properties do not form in a vacuum but are conditioned on a number of other structural parameters such as the size of the network, the individual properties of the nodes, among other factors (see Kadushin 2012). This paper argues that social network properties also derive from the organizational ecology that structures the networks in specific ways.

Literature Review

The two foundational ideas on which this paper builds are that of Blau space and Affiliation Ecology. Much as human beings may be represented in geographic space in terms of physical locations, physical coordinates, and physical distances; humans may also be represented in social space in terms of social locations, social coordinates, and social distances. One common representation of this social space is known as Blau space (McPherson 1983; McPherson and Ranger-Moore 1991). The ideas that inform Blau space were developed by Peter Blau (1977) but were named "Blau space" by Miller McPherson in his honor. Continuous[63] socio-demographic characteristics such as age, income, and years of education are used to form a k-dimensional space. These characteristics are referred to as Blau parameters.

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[63] While there are approaches to model social distance between categorical variables such as gender and race, doing so in the context of Blau Status Analysis presents a number of difficulties. While the categorical variables of *organizations* can be represented (e.g. percent of women or percent of Black), there is no validated technique that allows this for the representation of *individuals* in Blau space. This is because the categories that have no internal ordering (e.g. men and women; Blacks, Whites, Asians) cannot be easily arranged in a non-arbitrary manner along a Blau dimension (for individuals) in the way that continuous traits such as age and education can be. However, there are other ways to incorporate them into the analysis, which we do in the methodology section.

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Individuals are then populated in this space based on their attributes along those dimensions. Each person is represented by a set of k coordinates, which correspond to the person's attributes on the Blau parameters.

A key process that sorts individuals in Blau space is homophily, which is the tendency for individuals to associate with those who are similar to themselves (Lazarsfeld and Merton 1954). This may reflect preference due to the comfort persons feel in associating with similar others but it may also reflect demographic availability (McPherson, Smith-Lovin, and Cook 2001). As a consequence of homophily, proximity of individuals in Blau space is positively related to the likelihood of them forming a tie and influencing each other. Consequently the arrangement of ties or edges in Blau space is not random but is highly patterned. The edges are in effect sorted into particular localized regions of Blau space.

McPherson (1983) has shown how Blau space can be used to conceptualize the ecology in which organizations are competing for members. The affiliation ecology tradition has restricted its scope to voluntary associations (i.e. organizations) such as church groups, recreational clubs, and professional organizations. A different research program has applied a similar ecological analysis to firms (Hannan and Freeman 1989)[64]. There is a cornucopia of voluntary associations and they exist for a number of purposes and require a variety of resources. However the one resource that all voluntary organizations require to survive is the *time* of their members. This need intersects with Blau space in two important ways.

First, voluntary associations tend to recruit new members primarily from among the associates of their existing members; a person is more likely to join an organization that already

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[64] There is an important difference between two types of ecologies because fitness is defined differently. For for-profit firms, fitness is defined by the market where the goal is to maximize profits, whereas for non-profit organizations fitness is largely defined by membership growth, with the goal of maximizing recruitment. However, in the case of firms lowering recruitment – cutting staff – may actually be more desirable.

includes his/her friends. And because the networks through which organizations recruit are constrained by homophily, organizations are forced to recruit members from a particular area of Blau space. This area of Blau space is known as the organization's niche and is a central theoretical concept in affiliation ecology. Second, the amount of time that any one person can contribute to their memberships as well as the number of persons available in any given segment of a population (i.e. area of Blau space) is limited. Consequently, organizations whose niches overlap are in competition with one another over the same limited pool of resources (i.e. member time). Indeed, the more organizations attempt to draw members from the same area in Blau space, the more competition they experience amongst each other. Competition is a defining dynamic of affiliation ecology, and the degree of competition in a particular region of Blau space has predictable effects on organizational memberships.[65] Areas of Blau space that experience high competition, experience greater turnover, as members are recruited away by competing groups (Popielarz and McPherson 1995). Moreover, efforts to recruit new members from a competing niche will meet less success as rival organizations pursue the same individuals. On the other hand, areas of relatively low competition will produce less attrition and more successful recruitment.

More concretely, McPherson described a way to operationalize the organizational niche and how to represent inter-organizational competition in terms of Blau space. Let us imagine an ecology of a small town of 30,000 people that happens to have only three organizations who are active. There is a Yacht Club, a Sailing Club, and a Faculty Club. Let's suppose that each organization has fifty members. Each of the 150 members occupy certain coordinates in Blau

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[65] The organizations need not be aware that they are competing with each other; As long as two organizations are attempting to exploit the same pool of finite resources, they are competing with one another and will influence each other's outcomes.

space. We could further represent the niches of the three organizations. Let us suppose we are only interested in two Blau parameters – income and education. The niche of a continuous variable is measured by taking the mean of all organizational members and extending it out 1.5 standard deviations in opposite directions along the dimension in Blau space. Doing so for two dimensions creates a simple box (though higher order dimensions cannot be easily illustrated on paper). For example let's suppose the 50 members of the Yacht Club have an average income of a $100K a year, with a 1.5 standard deviation of $25K. The average education may be 15 years, with a 1.5 standard deviation of 5 years. While the club has only 50 members, the club niche includes all members of a community who earn between $75K and $125K and who have an education of 10-20 years. This includes a much larger number of people than the immediate members and will likely be in the thousands. If the Faculty Club includes members whose income ranges $40-$125K, the niches will overlap and some niche members (though not necessarily club members) will fall in both niches (namely those earning $75-$125K). See Figure 1.

Figure 1: The area of overlap represents the rea of competition
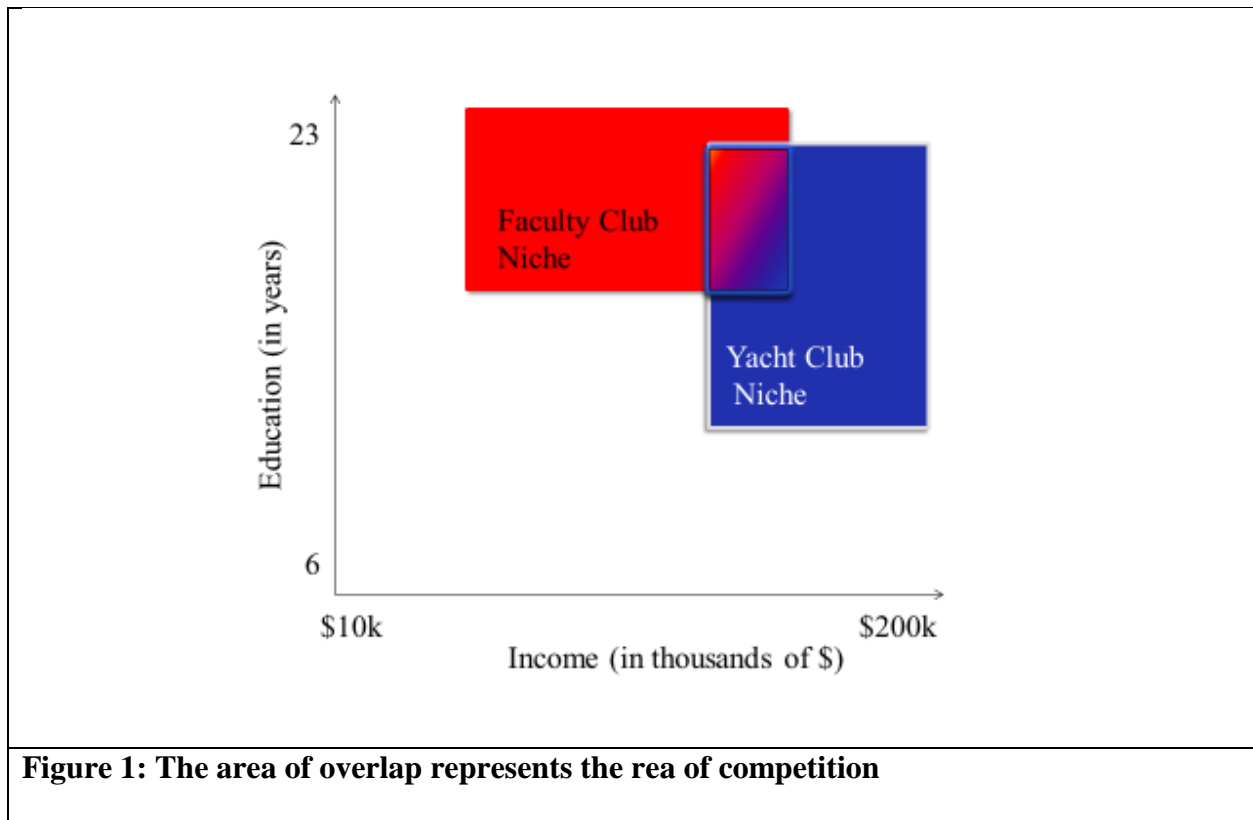
The affiliation ecology model has been extended to predict how niches move[66] and has even been applied to cultural forms such as musical styles[67]. The implications of the model have been analyzed in reference to the membership units or organizational unit of analysis. No one has worked out the implications of organizational competition back on the individuals over whom the organizations are competing. This is the object of Blau Status theory and of this paper.

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[66] Over time the niches of organizations will drift away from areas of high competition, where recruitment and retention are difficult, and towards areas of low competition, where recruitment and retention are easier. As a result of this process, over time the system will reach an equilibrium where the available resources have been divided between the competing organizations, but periodic changes in the quantity of potential members (i.e. the carrying capacity of the system) will generate shifts in the positions of organization niches (McPherson and Ranger-Moore 1991).

[67] The affiliational ecology model described above was originally constructed to explain the membership characteristics of voluntary associations, but it has been successfully used to explain individual familiarity with, and fondness for, various musical styles (Mark 1998), and to explain changes in the niche positions of musical styles over time (Bonikowski 2010). In other words, musical styles can be modeled as competing for fans in much the same way that voluntary associations compete for members. Indeed, liking a musical style is very much like becoming a "member" of that style, and in theory a wide variety of behaviors could be modeled by treating them as organizations to be joined or left (McPherson 2004).

Mechanism: Network Catalysis

Blau statuses are meaningful because they exert a force on the networks of their occupants. We now turn to the mechanism that describes how they do so. Due to homophily, ties are more likely to form among individuals who are proximate in social space (McPherson et al 2001). Recruitment into organizations occurs through network ties and organizations tend to become overwhelmingly homogenous encouraging contact among similar individuals and discouraging contact between dissimilar ones (Popielarz & McPherson 1995; McPherson & Smith-Lovin 1986). The recruitment occurs from the organizational niche (McPherson 1983). Once individuals are recruited into their organizations, ties between them become much more likely (Feld 1982). Because of demographic homophily organizational members are more likely to be similar and have ties to one another as well as to similar others who are not members of the organization itself but are members of the organizational niche.

As organizational competition sorts the members of its ecology into Blau statuses, it further exerts an important effect on the networks in which those members are embedded. It does so by changing their *associate choice set* (ACS), or the set of individuals that have a high probability of forming a tie to the ego. The ACS includes two types of associates: second-order associates and weak tie associates. Second-order associates are not acquainted directly with the ego, but are acquainted or friends with someone who is tied to the ego. Weak tie associates are directly acquainted with the ego, but are not strong friends, and include, but are not limited to, individuals known by face. Common examples of weak-tie associates are colleagues, neighbors, or co-workers (who are not *also* strong friends).

Organizational competition systematically alters the ego's ACS by making contact between persons more or less likely. Individuals who are in the area of organizational

competition experience a lowering of the average path length and an increase in the frequency of contact or exposure between any two niche members, while individuals outside the area of niche competition experience a lengthening of the average path length, making contact less likely. This is a process I term *network catalysis*[68]. In chemistry a catalyst allows a chemical bond to form at a faster rate and with less energy than normally required; in our theory, organizations lower the difficulty of forming social bonds, and thus catalyze the formation of social ties. The organizations acts as foci (Feld 1982), making ties among its members more likely[69]. This in turn lowers the average path length between the individuals who are part of the social networks of the organizational members, thereby increasing the ACS of everyone (members and non-members) in the niche. That's because individuals who are members of an organization increase the likelihood that their acquaintances and second-order friends will meet each other. Moreover, because the friends of organizational members are likely to come from the same area of Blau space (encompassed by the organizational niche) as the members, both the members and their friends are likely to form ties to one another through homophily. Suppose John and Paul are part of a Salsa troupe. They both decide to meet up at an informal party. While they go separately, each brings along a friend. John brings Jose and Paul brings Pedro. Now Jose and Pedro have a higher chance of becoming friends, even though neither of them are members of the Salsa troupe, because of the tie between their friends. See Figure 2.

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[68] I realize that John Padgett and Walter Powell have a similar term in *The Emergence of Organizations and Markets (2012)*. Their "organizational catalysis" and "organizational genesis" are in no way related to the way I am using the catalysis term.

[69] This is somewhat similar to Scott Feld's idea of a foci. Feld defines a foci as "any social, psychological, or legal entity around which joint activities are organized" (Feld 1981:1016). The niche would not be a foci since it in-it-of-itself does not bring people around joint activities. It is simply a part of social space from which organizations recruit their members. Feld confirmed this in a personal communication.
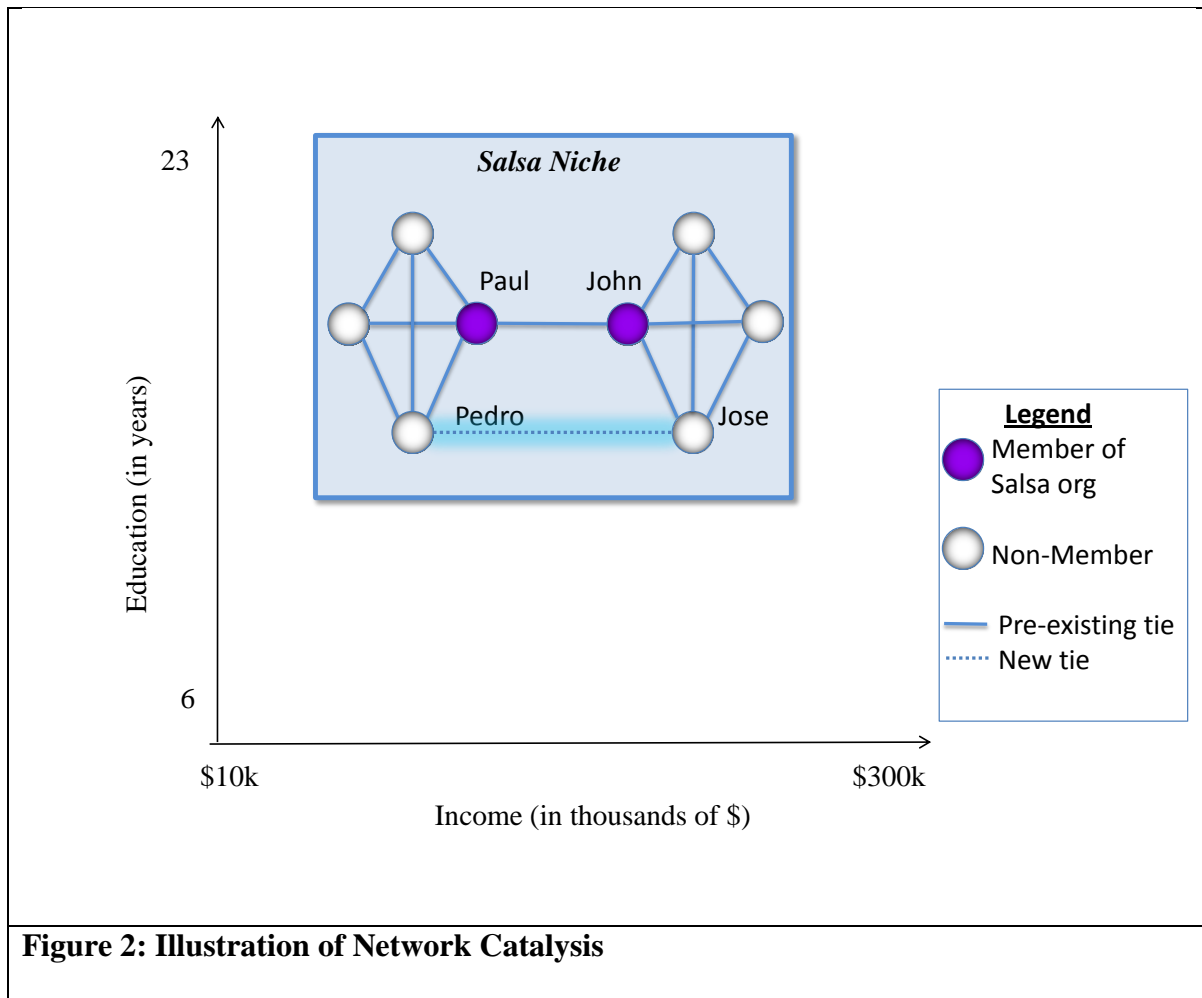
Figure 2: Illustration of Network Catalysis

The essence of catalysis is that persons who are members of an organization *who may or may not be associates* introduce their friends (who are non-members) to one another. This allows ties to form over greater social distances than homophily would usually allow. Figure 3 illustrates the process. The white nodes are organizational members. The purple nodes are their associates. Catalysis occurs when organizational members facilitate a tie between their niche friends (the purple nodes).

Figure 3: Catalysis
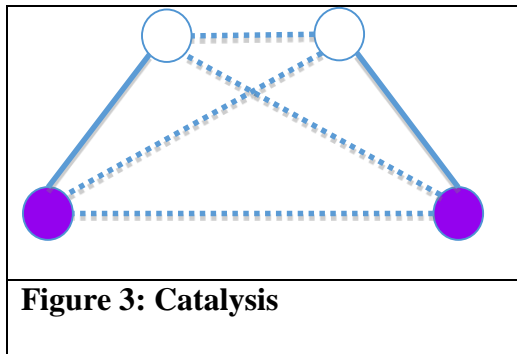
This may occur by a variety of paths. Three of the most common paths are:

Recycling of members: Organizations build ties through a foci effect. However, almost every voluntary organization has some rate of turnover. When members leave an organization they don't necessarily abandon the ties they have made in that organization. A person interested in dancing may try the Salsa Club, the Tango Club, the Swing Club, and even the Ballroom Club. As they move between clubs, they form new associates and introduce existing associates to one another.

Formal Association: members may bring along and introduce their colleagues at organizational events by inviting their associates to try out. Because organizations have regular meetings they are more effective at creating a forum for ties to form between members and visiting non-members. Two members of the Salsa club may invite his or her friends to join them for one event (as participants or spectators), which increases their likelihood of meeting one another.

Informal Association: members may introduce their colleagues at informal or non-organizational events and occasions such as birthday parties or get-togethers. A member of the Tango club may have a barbeque where he invites members of the Tango club and their associates, increasing the likelihood of a tie between associates.

Some of these paths may occur outside the organizational context but organizations concentrate two forces of tie formation: homophily and foci. Any two persons can introduce their

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friends to each other and have those friends form a tie. However, those two persons are more likely to do so if they 1) know each other through an organizational co-membership and 2) their friends are similar to each other, which is the case if they are in the same organizational niche. Organizations therefore act as a catalytic agent in tie formation among niche members.

Blau Status Theory

Voluntary groups compete for members much like commercial groups compete for customers. Critically, this intense competition affects not only the members but others in the organizational ecology in which the competition takes place. Because the competition for members can be profitably analyzed as taking place from niches located in Blau space, the constituents that populate Blau space may be analyzed into several distinct types based on their position in the competitive ecology. We refer to this position as a Blau status.

DEFINITION: Blau Status is a position an entity occupies in Blau space in relation to the ecology of competing organizations.

We use the more abstract term "entity" because, as we shall see, Blau statuses can express three units of analysis: the individual, the dyadic, as well as higher-order structures. The competitive ecology is defined by the presence of at least two entities[70] that are competing for members. For our purposes the entities are organizations but it may also be possible to apply the analysis to other entities modelled in Blau space, mutatis mutandis, such as cultural products (Mark 2003) or musical styles (Bonikowski 2010). The Blau Statuses emerge from the inter-organizational competition for members and they can characterize several different units of analysis of interest to network researchers. They may characterize individuals, dyads, and higher-order network

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[70] Though niches as such can exert an independent causal effect as well.

units. They may be network-dependent in that they require certain kind of network information and they may be network-independent in that no network information is required. Table 1 illustrates these points. We argue that occupying a particular Blau Status affects a plethora of social outcomes and provide the mechanisms by which this happens. We begin by identifying a systematic typology of Blau Statuses and proceed to describe what each type consists of and how it exerts a causal force.

Table 1: *Types of Blau Statuses*

	Node-Level	**Dyad-Level**	**Higher-Level**
Network Dependent	Outsiders, Insiders, Crevices	Co-Niche Membership	NicheCentrals
Network Independent	Spanners	B-Distance	Niches

Node-Level Blau Statuses

The most basic Blau statuses are insiders and outsiders. *Insiders* are individuals whose coordinates in Blau space fall within one or more niches in the competition ecology. They represent persons who are occupants of the organizational niche, though not necessarily members of the organization itself. To continue the aforementioned example, anyone whose coordinates fall within any of the three niches of Sailing Club, Faculty Club, or Yacht Club is an insider (See Figure 4). Insiders are at risk of being recruited into the organization and their networks likely intertwine with those of the organizational members. Because niches focus the network, making the area inside them more dense, insiders may have a bigger and more diverse network composition, have greater social activity, and have more tolerant and worldly beliefs.

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  ┌─────────────┐                              ┌─────────────┐
  │  OUTSIDERS  │                              │  INSIDERS   │
  └──────┬──────┘                              └──────┬──────┘
     ┌───┴───┐                                    ┌───┴───┐
┌─────────┐ ┌─────────────┐          ┌─────────────┐ ┌─────────────┐
│ Crevices│ │ Peripherals │          │  Exclusives │ │ Manifolders │
└─────────┘ └─────────────┘          └─────────────┘ └─────────────┘
```

Figure 4: Node-Level Blau Statuses

Outsiders are individuals whose coordinates in Blau space fall outside all niches in the ecology. If the ecology was populated by two additional clubs such as the Sailing Club and the Faculty Club the outsiders will be any member of these clubs who are outside their niches [See Fig.1]. When the system is in equilibrium[71] such individuals are unlikely to be of interest to any organization and their network are less dense and largely do not overlap the networks of organizational nichers. Since niches absorb a disproportionate number of the ties, outsiders may have lower out-degree, have a more homogenous social network, to have less social activity, and to have more sheltered social views. This status is particularly interesting because it allows us to think about being peripheral in a whole new way.

Insiders may be further divided into *manifolders* and *exclusives*. Manifolders are individuals who occupy more than one niche and exclusives are individuals who occupy exactly one niche. In a typical ecology, niches often overlap and individuals are likely to wind up in multiple niches. For example some individuals in the Yacht Club niche only belong to that niche, while others belong to both the Faculty Club niche and the Yacht Club niche. See Figure 5.

Outsiders may be further divided into crevices and peripherals. Crevices are outsiders who occupy a position between two niches. For example a person may be located between the Sailing Club niche and the Yacht Club niche but not fall into either niche. If the age bounds of

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[71] There is little or no niche movement as the organizations have settled in their respective positions.

the Sailing Club niche are 21- 28 years old that of the Faculty Club niche are 32-65, then someone who is 30 may fall in between the niches. Such a person may have ties to either niche. Peripherals are outsiders who do not fall between two niches and are usually located at greater distances from any niche. Assuming there are no other niches, someone who is 15 or 65 would be a peripheral. Peripherals are typically the most isolated from the main network clusters.

We can incorporate network information to talk about additional statuses. Spanners are individuals who have ties to other individuals who are members of a different niche. There are two ways one may be a spanner: as an outsider and as an insider. Crevices that have ties to other niches are considered outside spanners. See Figure 5. The 30 year old person who is neither a member of the Faculty Club niche nor a member of the Sailing Club niche may know members of both niches. Insiders who have ties to a manifolder are considered insider spanners. For example members of the Faculty Club niche may know another Faculty Club niche member who is also in the Yacht Club niche. Spanners have overlapping networks between the various niches and may therefore play the familiar roles of brokers connecting the various dense areas of the network.
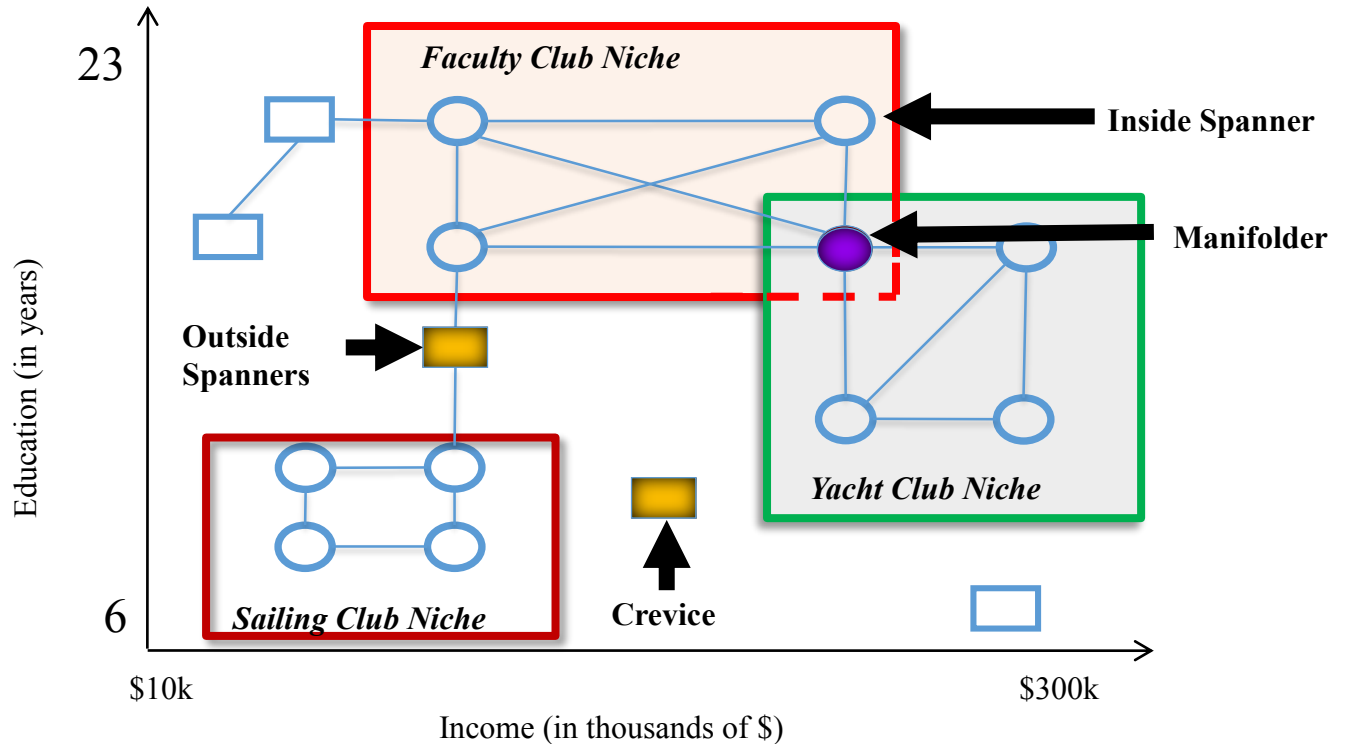
Figure 5: Illustration of Node-Level Blau Statuses

Notes: The geometrical shapes represent individuals arrayed in Blau space. The squares are their respective niches. Insiders are represented with circles and outsiders are represented with squares. Exclusive insiders and peripheral outsiders are hollow.

Dyad Level Blau Statuses

Blau Statuses can also characterize dyads. The distance in a given Blau space between any two nodes that have a tie can be computed using Euclidean distance or Mahalanobis distance (De Maesschalck, Jouan-Rimbaud, and Massart 2000). In this case the status is continuous and refers to a dyad's proximity in Blau space. Individuals who are proximate in Blau space are expected to be more similar than individuals who are distant. For example within the same Faculty Club niche, assume a 32 year old has two ties to two other niche members, one of which is 34 and another who is 60. He will have more other traits in common and a stronger connection

with the 34-year old person than with the 60 year old person.

Dyads can be also characterized by whether both nodes have the same niche membership or different niche memberships. A tie from one niche member to another same niche member is said to be a *co-niche tie*, whereas a tie from one niche member to another niche member is said to be a *spanning-niche tie*. A tie from a person in the Faculty Club niche to another Faculty Club niche member is a same niche tie, whereas a tie to a Yacht Club member is a different-niche tie. Co-niche ties are expected to be stronger ties than spanning-niche ties because of homophily.

See Figure 6 for an illustration of Dyad-level Blau Statuses.
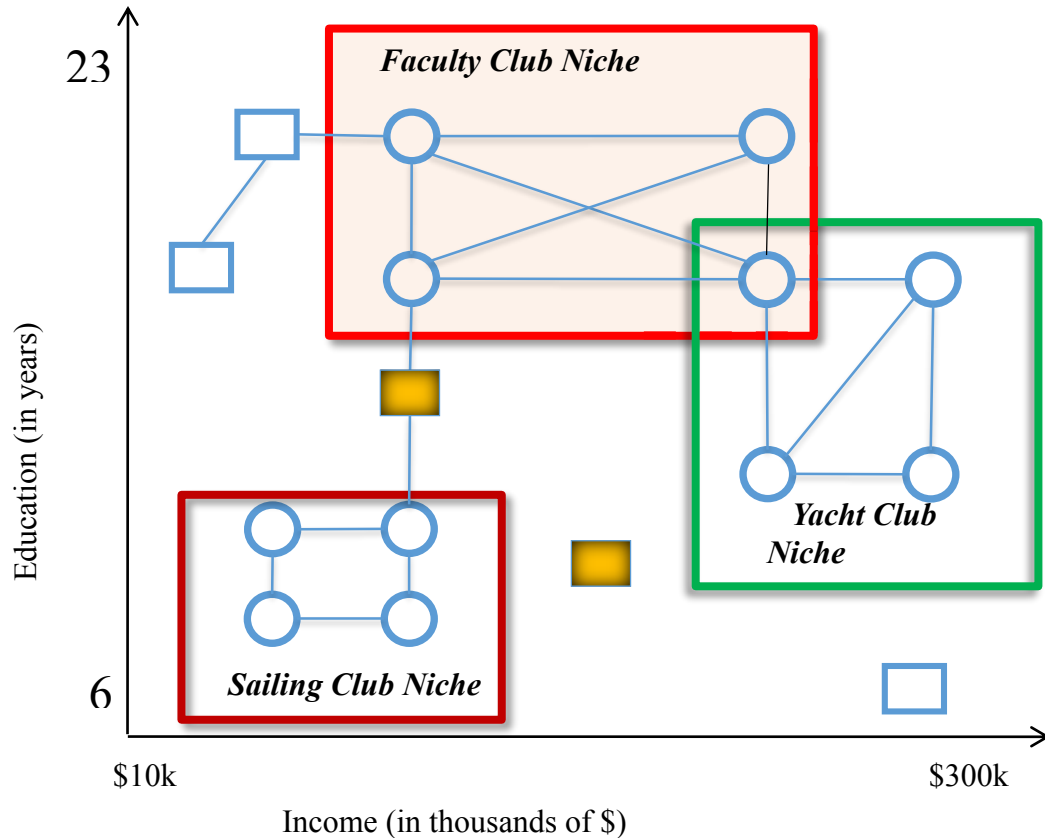
Figure 6: Illustration of Dyadic and Higher-Order Blau Statuses

Notes: The distance between any two individuals who have a tie may be measured using Euclidean distance. For example we can see that the A-D dyad is shorter than the A-B dyad. We can see that the dyads A-D, A-B, and D-B are same niche dyads, whereas the dyads A-C, B-C, and B-D are different niche dyads. Furthermore the Faculty Club, the Yacht Club, and the Sailing Club all form distinct niches. We can see that the Faculty club captures the most edges out of all the niches; it is the densest niche. It is therefore the central niche and is represented with a shade.

<u>Higher-Order Blau Statuses</u>

Finally the niches that populate Blau space and even the ecologies themselves can be

analyzed using Blau Status Analysis. Each ecology can be analyzed into its own set of niches.

Niches, as we shall see, represent communities and dense network clusters, which have more ties

to members within the niche than to members outside of it. In the case of our hypothetical

ecology, there are three niches. Usually a much larger set of niches exists and niches themselves can be distinguished into two broad types (common in the affiliation ecology and population ecology traditions). There are generalists who recruit form a very large swath of social space (e.g. Local chapter of United Way) and specialists who specialize in recruiting from a relatively narrower part of social space (e.g. Local chapter of Veterans of Foreign Wars). We can consider niches that capture the largest number of the ties in the network (out of all the niches) as the central niches. Central niches, by definition, have the highest density in the ecology.

Ecologies in turn can be analyzed in terms of the amount of competition they contain. Ecologies that are highly overlapping are said to be less stable and more competitive than ecologies that are partitioned into separate niches with hardly any overlap. The structure of the niches and the structure of the ecologies will impact the way Blau statuses operate and how many will populate the space. Generalist niches will produce many manifolders while specialists will produce many exclusives. Ecologies with little or no competition will result in many exclusive niches whereas ecologies with intense competition will result in many manifolders. A Blau Status Analysis therefore requires one to examine the ecology and the niches.

BlauNet: A Tool for Blau Status Analysis

Computing these Blau statuses, diagnosing the niches, and mapping the ecologies can be a laborious process. Therefore all the Blau Statuses mentioned in this paper as well as the niche and ecology diagnostics can be computed using a free software program called BlauNet[72], which is available with the documentation and the source code from the Cran website[73]. The manual for the program is included in the Appendix of the dissertation. The program operates in the R

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[72] The program was developed by myself, Liuyuan Chen, George Berry, and Matthew Brashears.
[73] http://cran.r-project.org/web/packages/Blaunet/index.html

programming environment. We welcome improvements and additions to the program. The essential capabilities of the program is to compute niches, node-level characteristics, and dyad-level characteristics. In addition the paper also computes competition coefficients (McPherson 1983).

PART II: TESTING BLAU STATUS EFFECTS EMPIRICALLY – THE EFFECT OF ORGANIZATIONAL COMPETITION ON NETWORKS

I now turn to testing a specific kind of Blau status – the manifolder and its effect on network properties. The goal of this section is to test some of the theoretical arguments empirically using a dataset that has organizational affiliation as well as network data.

Where do Network Properties Come From? An Organizational Niche Account

Social network analysis has developed a plethora of measures characterizing the different properties of networks. An important research agenda of social networks analysis is to understand how these properties are generated. Traditional accounts have focused on individual-level differences such as personality traits, distribution of attributes, and even norms (Bearman, Moody, & Stovel 2004) in generating network structures. We seek to move beyond individual-level accounts and consider a higher-level of aggregation – that of the competition between organizations. We claim that organizations catalyze the network, beyond a mere foci effect. The presence of organizations creates ties among individuals who are not members of the organizations, which is a much larger pool. We proceed to demonstrate this by extending the methodology of affiliation ecology.

Organizations anchor the networks by concentrating ties in their respective niches. The niches structure an associate choice set making ties among niche members more likely. The more niches a person is a member of the larger their associate choice set and the larger their number of associates. This lead to the following hypotheses:

H1: Niche Network Size Hypothesis: The more niches an individual belongs to the larger their social network is going to be.

Since niches create dense communities, belonging to multiple niches is likely to position the

person more centrally in the network compared to persons who belong to fewer or no niches.

> **H2: Niche Centrality Hypothesis**: The more niches an individual belongs to the more central they are going to be in the network, adjusting for other factors associated with network centrality.

Niche membership is a theoretical construct and most members who are in an organizational niche do not know they are in a niche. Unlike "organizational membership" or "identity membership" where the categories may map on to the cognitive categories of the actors, niches are analytic categories that are not readily apparent to the actor. The reason why organizational niches exert an effect is because they concentrate dense clusters of persons and make ties between those persons more likely.

> **H3: Niche Triangle Hypothesis:** A triad is more likely to close when all the nodes are members of a niche. In other words, the niche is more likely to have clustering.

Data, Analytic Strategy, and Estimation Method

One of our goals was to see whether Blau Statuses explain network characteristics. To do so we needed a corpus that had three types of data: (1) Nodal data: the individual-level characteristics or attributes of each respondent; (2) Network data: the network ties that each respondent has to other respondents – preferably sociometric but some network-dependent Blau statuses can be computed from egocentric data; (3) Affiliation data: the clubs and organizations the respondent belongs to. In addition to having the three types of data – individual-level, network-level, and affiliation level – the ecological units need to be sufficiently large. An ecological unit refers to the ecology in which competition takes place. Several datasets contain the three types of data, but they sample data from the respective ecological units such that the

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per-unit population is too small. For example the GSS has individual, affiliation, and network data but the units are sampled such that any one city in the US is likely to have only a few individuals. It would be invalid to compare the competition of a Veterans group in San Francisco with a Bingo group in Los Angeles, because the two exist in different ecologies. One commonly used dataset that contains the three types of data necessary to test our argument and which had the proper ecological unit was the National Longitudinal Survey of Adolescent Health (Add Health) dataset.

Data

The National Longitudinal Survey of Adolescent Health (Add Health) is a large effort to collect data on a nationally representative sample of adolescents in the United States, grades 7-12 (Harris 2009) and track a portion of those individuals over time. These data were gathered by taking a stratified sample of American high schools (both public and private). To ensure that there was longitudinal data at Wave II for students who hadn't entered high school yet at Wave I each high school was paired with a feeder school, which usually included a junior high school that sent the largest amount of students to the high school. The data gathered includes detailed information on respondent demographics such as sex, race, national origin, measures on a wide variety of attitudes and behaviors, and contains information on participation in voluntary associations such as the various school extracurricular activities. The dataset also contains information on the socio-centric social networks of the respondents. The dataset represents an ideal corpus for this study because it combines information on three types of data necessary to test the argument and it contains bounded ecological units in the forms of schools, 16 of which , known as the saturation schools, contain nearly complete populations of the schools.

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Add Health is longitudinal and is currently up to Wave 4. We focus our attention on Wave 1 because it contains virtually all of the variables required for our analysis, many of which are not repeated in subsequent waves. The saturation schools (in-Home) include 3,702 students. The data were gathered in 1995. There are two versions of the dataset, one is public and one-containing the network data, is restricted

Analytic Strategy

The article follows an analytic strategy consisting of two phases, each focusing on a different level of analysis. To assess the Niche Centrality Hypothesis I compute the various centrality scores of individuals in the niche and estimate models that control for other individual-level variables that may affect centrality. To assess the Niche Triangle Hypothesis I focus on the dyadic level and use an exponential random graph model to estimate the triangle attribute parameter, where the attribute is the niche level. Again I control for alternative factors that may affect triangles including higher-order structural effects. To assess the first hypothesis I focus on the Add Health In-Home network, provided by respondents from 145 schools and 20,745 individuals. To assess the second hypothesis I focus on two of the largest saturation schools in the Add Health dataset.

Dependent Variables

To assess the Niche Network Size Hypothesis I used a measure of incoming ties to measure the size of the person's popularity. This is known as degree centrality (Freeman 1979; Wasserman and Faust 1997). In networks that are directed degree centrality can be decomposed into centrality based on the nominations one makes (out-degree centrality) and the amount of

nominations one receives (in-degree centrality). Indegree centrality is more useful as a metric in

that it captures non-reciprocated ties and depends on the alters. This reflects popularity (Moody

et al. 2011) as high indegree actors attract more nominations relative to others (Freeman 1979;

Wasserman & Faust).

Indegree is also a kind of primitive measure of network centrality. However it is limited

in that it does not exploit information about the person's position in the larger network relative to

the other nodes. High degree nodes can be relatively peripheral despite their large number of ties.

Another sense of centrality is to consider the geodesic or shortest path from every node to every

other node – and the extent to which a given node is in the geodesic. The more such shortest

paths depend upon a particular node the more central that node is. Betweenness centrality of a

node is the sum of the shortest paths among all pairs of nodes i and j in the network that pass

through that node, divided by the total number of geodesics between nodes i and j. Stated

formally:

$$Betweeness\ (k) = \Sigma \frac{G_{ij}(k)}{G_{ij}}$$

Where G_{ij} refers to the shortest paths between node i and node j and $G_{ij}(k)$ refers to the number

of such paths that pass through k[74].

Independent Variables

The main Blau status considered here was that of manifolder. There were five

dimensions that were used to do compute construct the Blau space. The dimensions were Body

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[74] To be more precise, direct ties between i and k as well as j and k are not counted, though in some variants of betweeness centrality they are. I used the most common way betweeness centrality is computed in the literature, where direct ties are not counted (Freeman 1979, Wasserman & Faust).

Mass Index (BMI), Peabody Picture Vocabulary Test (PVT), Physical Maturity, Age, and Socio-economic Status. These variables were confirmed to structure association using exponential random graph models and quadratic assignment procedures. Additionally they have been found to structure association in previous studies (Schaefer et al. 2011; Simpkins et al. 2013) and they have been used to construct Blau space in other studies (Brashears, Genkin, Suh Under Review). BMI was constructed from the height and weight measures available in Add Health using the standard method (Schaefer, Kornienko, and Fox 2011). The PVT was administered by Add Health to respondents and is considered a proxy for academic aptitude. Physical maturity was assigned by Add Health interviewers by having them rate a respondent on a 1-5 Likert scale of how mature they appeared to be relative to peers of the same age. Age was computed by subtracting the respondents birthday from the date of the interview. SES was computed by taking the highest level of education obtained by the parents.

Next, the niches were constructed using the 33 different extra-curricular clubs that students were asked to indicate their membership in. In addition, following Brashears, Genkin, Suh (Under Review) we used the student's membership in gangs, religious youth groups, and employment in full-time work organizations. The total number of niches was 36 and niches were calculated separately for each school.

Finally, the manifolder variable was computed by counting the membership in each of the 36 niches. About half the students in the data were members of at least one niche. The whole procedure was done for each school.

Control Variables

The model included a number of control variables that were included in order to rule out alternative interpretations. Three classes of alternative interpretations were considered.

An immediate alternative interpretation is that any effects attributed to niche membership can actually be attributed to organizational membership. I therefore constructed a sum metric for organizations. The correlation between niche and organizational membership is 14% and the ratio of members to nichers is about 1:10, though there is substantial variation.

Next I consider the standard demographic variables that are likely to impact association: school grade, sex, and race[75]. There is no current method to model such categorical variables for individuals in Blau space and so they are included as controls. The variables were taken from the In-Home portion of the Add-Health. In cases where values on them were missing, I used the student's answers from the In-School survey.

The other set of variables included are variables associated with the number of nominations a person might receive. We know that people are likely to form ties to those who exhibit a positive and outgoing mood and are less likely to form ties to individuals who are depressed (Connolly et al. 1992; Pollet, Roberts, and Dunbar 2011). I therefore included a variable for depression. The item asked respondents about how often they felt depressed in the last 30 days. I also included an item that asked respondents how often they felt happy. Other research has shown that attractive individuals are more likely to receive nominations and have larger social networks (Reis et al. 1982). I therefore included a variable on the physical

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[75] Race was recoded from the Add Health categories where students can select more than one race and Hispanic was included as a separate variable. Consistent with past analysis of Add Health (Goodreau, Kitts, Morris 2009) I recoded the categories such that the multiracial individuals there were assigned to "Other" and Hispanic of any race were assigned to a racial category. Not doing so would have expanded the number of racial categories considerably and since the number of individuals in the distinct categories was fairly small, I recoded for the purposes of parsimony.

attractiveness of respondents as rated by the Add Health interviewers. In addition the interviewers also rated the respondent in terms of the attractiveness of their personality. Personality differences, particularly extraversion, have been found to be positively associated with network size (Roberts et al. 2008). Finally, in the context of adolescent high school students researchers have found that membership in athletic organizations in particular was correlated with popularity (Ommundsen, Gundersen, and Mjaavatn 2010; Schaefer et al. 2011). I therefore included a dummy variable for athletic group membership.

In addition the model also includes the five parameter variables used to construct the niches themselves. The purpose of including such variables is to distinguish the effects of one's particular position in the social space from the linear effect of the parameters making up the social space. The claim I am making is that niches exert an independent non-linear effect. An alternative explanation is that the niches have the effect that they do because of the dimensions that make them up.

Lastly, because of a survey design quirk in Add Health some students were asked to nominate different number of friends. While most were asked to nominate up to ten friends (five male and five female), some were asked to only nominate two friends (one male and one female). Therefore it is important to use control for the number of friends students were given an opportunity to nominate.

Estimation Strategy

Negative binomial regression was used to estimate the effect of the various parameters on network size and centrality since the dependent variable is count data, number of discrete ties or number of paths that can take a finite number of values. Since the data is nested within schools,

robust standard errors were clustered within schools[76]. Finally, the Add Health-provided within school weights, which were used in all models to adjust for different sampling probabilities of students.

For the second stage of the analysis, which sought to ascertain the mechanism behind niche effects, I used exponential random graph models (ERGMs) since niche clustering is a higher-order effect that cannot be assessed using node-level estimation. Moreover, ERGMs allow one to assess effects of individual, dyadic, and higher-order effects simultaneously, which is appropriate if one has full socio-metric data. ERGMs seek to model tie formation between pairs of nodes conditional upon actor attributes and tie generating mechanisms at the network level (Robins and Pattison 2005; Robins et al. 2007a; Snijders et al. 2006). On the left side of the equation the model seeks to estimate the log odds of a tie between two nodes conditional on the rest of the network. On the right side of the equation the model seeks to estimate the parameters of network statistics, which correspond to local network configurations that are assumed to generate the global network topology. Examples of such configurations include triadic closure, stars, cycles, reciprocity. More formally:

$$\text{logit } (Y_{ij}|Y_{ij}^n) = \sum_A \beta_A \theta s_A(y)$$

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[76] While betweeness centrality is based on discrete count data of the geodesic paths, it is adjusted by the total number of paths. The outcome is therefore not discrete. Therefore, as a robustness check, I also ran an ordered logistic regression for the betweeness centrality dependent variable, after categorizing the response variable into either three or four quantiles. The largest category of 0s was always more than half the data and so the number of categories with observations was limited to either three or four categories. The results were consistent in terms of magnitude, direction, and significance. In fact the magnitude of the coefficients slightly improved. Thus, the results presented here are conservative and do not throw out information by reducing quantitative data into categories.

Where Y_{ij} is the probability of the tie between i and j, conditional on the rest of the network Y_{ij}^n; A represents the network configuration; $\theta s_A(y)$ represents the amount by which the network statistic S changes when one toggles between $0-$ no tie between i and j to $1-$ a tie between i and j; β_A is the parameter estimate expressed as an increase in the log odds that a tie will be formed if the formation of this tie will increases the corresponding network statistic by 1 unit (Wimmer and Lewis 2010). I consider the networks of two of the largest schools in Add Health, which I fictionally refer to as James Polk High School and Zachary Taylor High School. Following Gooderau Kitts and Morris (2009) the ERG models consider three types of effects: the main effects of the variables (sometimes termed sociality effects), the dyadic effects of the variables, and triadic or higher-order effects. Sociality effects consider whether persons with certain attributes are more likely to have ties generally than those in the reference category. For example, do women have more ties than men? Homophily effects consider whether persons with certain attributes are more likely to send ties to others who share those attributes. For example, do women send more ties to other women than to men? Triadic effects consider the effects of higher-order properties in the network. For example, is person A more likely to send a tie to person B if both of them have a tie to C. Those can be mixed with attributes. To continue the previous example, is the tie from A to B more likely if all three nodes happen to be women. The terms that captures such effects are GWESP and GDWSP. The GWESP term is a measure for the tendency to form triangles or transitivity but is geometrically weighted such that the more partners a dyad shares, the more likely it is to form a tie. The GWDSP term refers to a countering triadic tendency, which is the likelihood of a closed triangle regardless in all pairs of nodes (rather than only pairs that have a tie) when both nodes share a common friend or friends.[77] Both

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[77] In the ERGM framework, a dyad refers to a pair of nodes whether they do or do not have a tie. An edge refers to a pair of nodes that have a tie. GWDSP considers triangle for dyads hence the "D" while GWESP considers the

terms are strongly advised to avoid degeneracy (Goodreau 2007; Hunter, Goodreau, and

Handcock 2008; Robins et al. 2007b) and are indeed standard on many models that include

higher-order effects.

Results

The models confirm the three hypothesis. The Niche Network Size hypothesis is

confirmed by the estimated models (Table 2). Model 1 shows a positive and statistically

significant effect of Manifolders on Indegree, controlling for demographic factors. The strength

of the effect is somewhat modest. Non-Whites tend to enjoy lower popularity compared to

Whites, but there is no effect for gender. Ninth-graders tend to have slightly more friends than 7^{th}

graders. Physical attractiveness and membership in athletic groups are also positively associated

with larger indegree, confirming past research. Model 2 indicates that the effect of Manifolders is

preserved, even when we add the parameters making up the Blau space. Some of those

parameters are significant suggesting that older students have more friend nominations, more

intelligent students (as measured by the PVT) have more friend nominations, while students who

are heavier (as measured by BMI) tend to have less nominations. The important point to note

from Model 2 is that even controlling for those dimensions, the niches have an independent

effect, suggesting that there are independent ecological effects. Model 3 shows that the

Manifolder effect is preserved when we include organizational membership, which itself has a

positive effect on indegree.

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triangles for edges. When the two are included in the same model the GWDSP parameter may be interpreted as a
kind of structural imbalance, where i is not friends with j, despite having k as a friend.

Table 2: Negative Binomial Regression of Indegree

	Indegree					
	Model 1		**Model 2**		**Model 3**	
	B	*SE*	*B*	*SE*	*B*	*SE*
Affiliation Ecology						
Blau Manifolders	1.012***	(0.00210)	1.009***	(0.00342)	1.009***	(0.00338)
Org Membership					1.027***	(0.00765)
Demographic						
Sex (Males=ref)						
Females	1.042	(0.0612)	1.061	(0.0631)	1.050	(0.0618)
Race (White=ref)						
Black	0.461***	(0.0647)	0.502***	(0.0623)	0.503***	(0.0617)
Asian	0.742**	(0.0944)	0.783**	(0.0898)	0.779**	(0.0889)
Other	0.897	(0.220)	0.934	(0.192)	0.938	(0.190)
Hispanic	0.753**	(0.0931)	0.849	(0.125)	0.848	(0.128)
Grade (7th=ref)						
8th Grade	1.088	(0.145)	1.033	(0.137)	1.023	(0.135)
9th Grade	1.502**	(0.264)	1.364*	(0.227)	1.376*	(0.233)
10th Grade	1.216	(0.206)	1.065	(0.144)	1.082	(0.147)
11th Grade	1.305	(0.286)	1.077	(0.172)	1.089	(0.173)
12th Grade	1.182	(0.207)	0.894	(0.131)	0.900	(0.133)
Socialiability						
Happy	1.030	(0.0229)	1.020	(0.0270)	1.017	(0.0263)
Depressed	1.023	(0.0141)	1.021	(0.0131)	1.018	(0.0133)
PhysAttract	1.144***	(0.0109)	1.120***	(0.0117)	1.118***	(0.0112)
PersAttract	1.041	(0.0274)	1.037	(0.0339)	1.034	(0.0331)
Athletes	1.214**	(0.0977)	1.223***	(0.0949)	1.154*	(0.0975)
Blau Dimensions						
Age			1.069**	(0.0317)	1.066**	(0.0316)
SES			1.010	(0.0170)	1.008	(0.0178)
BMI			0.981***	(0.00500)	0.981***	(0.00522)
PVT			1.006***	(0.00125)	1.006***	(0.00136)
PMaturity			1.000	(0.0305)	0.996	(0.0303)
FriendLimit	1.544***	(0.187)	1.565***	(0.182)	1.582***	(0.184)
Constant	0.669*	(0.143)	0.220**	(0.132)	0.241**	(0.143)
lnalpha	0.454***	(0.0384)	0.440***	(0.0410)	0.436***	(0.0401)
Observations	2,338		2,338		2,338	
Log Pseudolikelihood	-8286		-8255		-8249	

Note: Robust Standard Errors are in paranthesis. *** p<0.01, ** p<0.05, * p<0.1

The Niche Centrality hypothesis is also confirmed by the models (Table 3). We see that there is a positive and statistically significant effect of Manifolders being more central in the network (Model 4). We also see that Blacks are less central than Whites but Asians, Hispanics, and Others are more central. This may occur because of highly dense clusters among Whites and among Blacks, whereas Hispanics and Asians may straddle both groups in terms of associates, thereby having high betweeness centrality. Almost every grade is more central than the 7th grade. This is because it is the lowest grade in the network. In fact we see the effect peaking in the 9th grade and slowly attenuating. This may reflect the fact that students form clusters over time. Those beginning high school in grade 9 are only settling into their respective communities and straddle different network clusters. By the 12th grade the friendship circles have settled and largely reflect one's grade peers. Happy individuals are also more central as are athletes. Model 5 shows that adding Blau dimensions to the models preserves the effect of Manifolders. We observe that older students as well as those with higher academic aptitude are also more central. Finally, Model 6, demonstrates that adding organizational membership does not compromise the effect of Manifolders. In fact organizational membership does not appear to contribute to centrality.

Table 3: Negative Binomial Regression of Betweeness Centrality

	Betweeness Centrality					
	Model 4		**Model 5**		**Model 6**	
	B	*SE*	*B*	*SE*	*B*	*SE*
Affiliation Ecology						
Blau Manifolders	1.027***	(0.00798)	1.026**	(0.0117)	1.026**	(0.0119)
Org Membership					1.026	(0.0285)
Demographic						
Sex (Males=ref)						
Females	0.840	(0.196)	0.904	(0.217)	0.887	(0.216)
Race (White=ref)						
Black	0.520***	(0.122)	0.597**	(0.150)	0.594**	(0.150)
Asian	2.548***	(0.670)	2.766***	(0.776)	2.752***	(0.776)
Other	1.772*	(0.529)	1.712**	(0.453)	1.727**	(0.452)
Hispanic	2.308***	(0.633)	2.623***	(0.831)	2.611***	(0.826)
Grade (7th=ref)						
8th Grade	3.636***	(1.322)	3.028***	(1.275)	2.991***	(1.208)
9th Grade	24.91***	(13.41)	16.61***	(10.60)	16.61***	(10.66)
10th Grade	16.01***	(7.737)	8.515***	(5.864)	8.645***	(6.075)
11th Grade	20.88***	(9.790)	9.133***	(6.630)	9.198***	(6.738)
12th Grade	16.43***	(7.555)	5.495**	(4.419)	5.547**	(4.501)
Socialiability						
Happy	1.091**	(0.0418)	1.094*	(0.0564)	1.094*	(0.0551)
Depressed	1.048	(0.0483)	1.038	(0.0388)	1.033	(0.0378)
PhysAttract	1.074	(0.120)	1.098	(0.102)	1.098	(0.104)
PersAttract	1.050	(0.0776)	1.065	(0.0765)	1.066	(0.0773)
Athletes	1.190**	(0.0888)	1.194***	(0.0822)	1.127	(0.133)
Blau Dimensions						
Age			1.262**	(0.135)	1.255**	(0.137)
SES			0.993	(0.0325)	0.992	(0.0329)
BMI			0.994	(0.0212)	0.994	(0.0213)
PVT			1.010***	(0.00358)	1.010***	(0.00378)
PMaturity			0.933*	(0.0374)	0.932*	(0.0368)
FriendLimit	9.526***	(4.467)	10.32***	(5.024)	10.44***	(4.990)
Constant	7.089***	(3.811)	0.121	(0.268)	0.135	(0.303)
lnalpha	7.197***	(1.892)	7.169***	(1.872)	7.167***	(1.872)
Observations	2,338	2,338	2,338		2,338	
Log Pseudolikelihood	-26909	-26909	-26901		-26900	

Note: Robust Standard Errors are in paranthesis. *** p<0.01, ** p<0.05, * p<0.1

The exponential random graph models lend support to the Niche Triangle Hypothesis (Table 4). Again the models consider two of the largest schools in Add Health, which I fictionally refer to as James Polk High School and Zachary Taylor High School. I exponentiated the coefficients from log odds to odds ratios to make them more interpretable. I consider pairs of otherwise identical models for each school. Models 1 and 4 consider the sociality effects and we find a positive statistically significant effect for Niches. This lends additional support to Hypothesis 1 in that manifolders have higher degree overall. We see a similar effect for being a member of multiple organizations. Non-whites are less likely to send ties in James Polk, whereas the effect is partly reversed for Zachary Taylor – while Blacks have no statistically significant difference as far as sending ties, Asians, Hispanics, and Others tend to send more ties than Whites. Zachary Taylor is an urban school where Whites are a minority group and Hispanics are in the plurality. Models 2 and 5 show that the Manifolder effect is retained for both schools. We see that there is a homophily effect on Niches in that individuals prefer others in the same Niche. There is also a preference for those who share organizational membership in James Polk. We also see that there is gender homophily in both schools. Racial homophily is present only in Zachary Taylor with an especially strong effect for Blacks. The absence of racial homophily in James Polk is not surprising since the school is overwhelmingly White. Models 3 and 6 consider triadic effects and find support for hypothesis three. Students are more likely to have a tie if they are members of the same niche and if the third person is also a member of that same niche. It confirms the intuition that niches are dense communities that organize tie formation. We observe the same effect for organizations in James Polk but not in Zachary Taylor. We observe strong transitivity in both schools. Both schools also exhibit a very strong mutuality effect in that ties are very likely to be reciprocated.

Table 4: Exponential Random Graph Models of Tie Formation in Two High Schools

| | James Polk High School‡ | | | | | | Zachary Taylor High School‡ | | | | | |
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | |
	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Edges	0.003***	(0.05)	0.003***	(0.321)	0.005***	(0.221)	0.001***	(0.123)	0.001***	(0.151)	0.001***	(0.352)
Sociality												
Manifolders	1.011***	(0.001)	1.011***	(0.001)	1.007*	(0.003)	1.004***	(0.001)	1.004***	(0.001)	1.004*	(0.002)
Orgs	1.083***	(0.01)	1.091***	(0.01)	1.035	(0.029)	1.012**	(0.005)	1.014**	(0.005)	1.018	(0.013)
Sex (Males=ref)												
Females	0.962.	(0.024)	0.982	(0.021)	0.946	(0.045)	1.072**	(0.022)	1.061**	(0.019)	0.993	(0.054)
Race (White=ref)												
Black†	0.899*	(0.047)	0.632	(0.306)	0.582**	(0.197)	0.923	(0.066)	0.31**	(0.097)	0.418***	(0.203)
Asian							1.478***	(0.062)	0.406***	(0.091)	0.579**	(0.193)
Other							1.176*	(0.077)	1.605***	(0.093)	2.006***	(0.191)
Hispanic							1.274***	(0.062)	0.548***	(0.093)	0.716.	(0.177)
Homophily												
Manifolders			1.251***	(0.065)	1.061	(0.083)			1.213**	(0.059)	1.149	(0.178)
Orgs			1.17***	(0.038)	0.948	(0.102)			1.044	(0.037)	0.894	(0.098)
Sex			1.613***	(0.034)	1.457***	(0.073)			1.816***	(0.032)	1.394***	(0.054)
Race												
White			0.69	(0.317)	0.553**	(0.184)			4.634***	(0.213)	3.075.	(0.597)
Black †					1.142	(0.552)			25.717***	(0.134)	12.336***	(0.238)
Asian									15.957***	(0.105)	6.496***	(0.172)
Other									0.635.	(0.246)	0.684	(0.711)
Hispanic									5.973***	(0.099)	3.903***	(0.174)
Triadic Effects												
Niche-Triangles					2.51***	(0.002)					4.667**	(0.586)
Niche-Organizations					0.706***	(0.029)					1.067	(0.331)
GWESP (fixed.0.25)					11.057***	(0.056)					8.404***	(0.214)

GWDSP (fixed 0.25)				0.872***	(0.012)			0.857***	(0.017)
Mutuality				28.307***	(0.185)			20.696***	(0.573)
AIC:	47410	47184	41337			63332	58791	54678	
BIC:	47468	47301	41511			63435	58997	54949	

Notes: Standard Errors are in paranthesis. *** p<0.01, ** p<0.05, * p<0.1; ‡The high school names used are fictional.

† Theodore Roosevelet High School was more than 90% White. The category "Black" refers to "Non-Whites" for that school.

Discussion

The data suggests that part of the Blau status analysis framework discussed earlier may have theoretical leverage. The manifolder statuses provide insight on the variation in network size and centrality and offer some evidence for the mechanism of catalysis. This further suggests that organizations catalyze the network, beyond a mere foci effect and that some network properties are better understood at the level of the organizational ecology.

The study does contain a number of limitations. While I outlined a number of different Blau statuses, only one was really evaluated and in respect to one aspect of social reality. Considering other Blau statuses as well other outcomes would be an important next step. Furthermore, because of the longitudinal limitation of the data[78] the direction of some of the effects are not certain. Is it that organizational niches converge on areas of high density or is it that they create them? This is not entirely obvious. An ideal dataset would consider niche dynamics and would collect affiliation data longitudinally.

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[78] Add Health contains longitudinal network data but not organizational data, which is only gathered at Wave 1.

PART III: APPLICATION OF BLAU STATUS ANALYSIS TO COVERT

ORGANIZATIONS

Blau Status Analysis is a versatile tool, applicable to multiple domains in social science. In this section I outline how BSA may be relevant to the problem of terrorism recruitment and identification. Conventional methods of identifying would-be or existing terrorists rely on crude techniques that end up victimizing innocent individuals. One such example is the hotly debated practice of profiling. Profiling relies on determining a list of "typical" attributes that most known group members share. The problem with this method is that it has a high false-positive rate in that the characteristics shared by terrorists may also be shared by non-terrorists. The alternative to profiling is to use individualized investigations. The problem here is that terrorists are by their very nature covert and are seeking to evade detection. Even if large numbers of people can be tracked, doing so may be very costly and impractical. Setting the threshold for investigation too highly will result in a high false-negative rate, allowing many individuals to escape discovery and carry out their attacks. An optimum technique is one that minimizes the false positive and false negative rates and maximizes the true positive and true negative rates. BSA may be an important framework that can contribute to this important area.

Dependent Variables

I seek to test the BSA methodology with a known illicit organization, the gang. The Adolescent Health dataset asks students to supply information on whether they "belong to a known gang". The question was asked using the Computer Assisted Self-Interview (CASI) mode to encourage truthful answers. The data is useful in that we have the "ground truth" of who the gang members are. It therefore allows one to test a predictive technique in how well it classifies

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the target population. The object of the analysis is to see whether models involving Blau statuses will add predictive value in detecting a covert population.

Independent Variables

The models includes two kinds of Blau statuses. The first model with Blau statuses contains membership in the gang niche. This represents a situation where we have enough information to construct the gang niche by potentially having a sample of the captured terrorists or knowing their background but not who is actually a member. The same variables as before: BMI, PVT, Physical Maturity, SES, and Age were used to construct the gang nich variable. In the next model I decompose the variable into two types of nichers: exclusive and manifold. Exclusive nichers are individuals that are only in one niche and no other niche. In other words, no other organization is competing to recruit such persons. We believe that such individuals are especially vulnerable to recruitment. The other kinds of nichers are manifold nichers who are individuals who belong to the gang and at least one other niche.

Control Variables

I used three sets of control variables to model gang membership. The rationale behind their selection is that they are alternative factors that security agencies use to identify members of covert networks. The most basic and controversial are demographic variables that are used to profile individuals. The intuition behind profiling is simple – if captured terrorists have certain characteristics that set them apart from the general population, than policing efforts should focus on individuals who have those attributes. The problem with this approach is that just because a set of traits are common among the targeted population does not imply that the people who have the traits are also in the targeted population. In a strict sense this fallacy is known in logic as

affirming the consequent. The security agencies argue that they realize that merely having a trait common among terrorists does not make you a terrorist, but it makes you more likely to be a terrorist. However, this approach is only feasible if the trait in question results not only in true positives (identifying actual terrorists) but also avoids false positives (does not falsely accuse persons who have the trait but are not terrorists). Having too many false positives is problematic because it not only violates the individual rights of innocent people but it may also make those very individuals – in the extreme case - become more easily radicalized and turn to violence, therefore exacerbating the very problem one is trying to solve. Nonetheless for comparison purposes I included demographic attributes that are relevant to the context of gangs in High Schools such as Race, Gender, and Grade.

I also included the set of variables used to construct the niches themselves. The logic for doing so is again to rule out the effect of the variables making up the niches. This is especially important if the claim I am testing is that the niches add value beyond conventional profiling approaches. It could be argued that the niches are just a more sophisticated form of demographic profiling and their effect is merely a reflection of the variables that make them up being associated with the membership group in question. I am therefore including them to test this alternative explanation.

Finally, I included a set of behavioral variables that are associated with deviant behavior. The behaviors are taken from Add Health's deviance index. They include painting graffiti, doing property damage, engaging in a serious fight, causing serious injury to someone, stealing more than $50, threatening someone with a weapon, selling drugs, being rowdy in public, and engaging in group fights. The answers to these questions were gathered by asking respondents whether they engaged in such behaviors. The intuition for including them is that individuals who

engage in deviant behaviors may be members of groups whose purpose is to engage in such behaviors.

Estimation Strategy

The analysis proceeded in three stages. First I use a logistic regression to establish a baseline effect of each of the three explanatory types, the demographic factors, the behavioral factors, and the Blau factors. Next I estimate a set of models with a mix of the three factors. Finally I compute the Receiver Operating Characteristic (ROC) curves for each of the models. ROC curves are a technique originally developed for radar detection but have been imported into epidemiology and social science for evaluating the effectiveness of binary diagnostic instruments (Cleves 2002; Pepe 2004). ROCs are plotted on a graph where the Y-axis represents the rate of true positives or sensitivity and the X-axis represents the rate of false positives or 1-specificity. The curves themselves represent the prediction curves from various classification models. A line that bisects the axis symmetrically represents random guessing (there are as many predictions that are true as there are false). The top left point of the space represents perfect prediction (100% true positives and 0% false positives). See Figure 7. Therefore the closer a curve is to the top left corner the better the model is at diagnosis. Each model can be compared by computing the area under the curve, the higher the area under the curve, the better the model. Models can also be compared using a test of equality to ascertain whether the difference between them is greater than chance (Cleves 2002; Pepe 2003). The tests are especially useful for my purposes in ascertaining whether Blau status analysis can add value to models that seek to identify members of covert organizations.
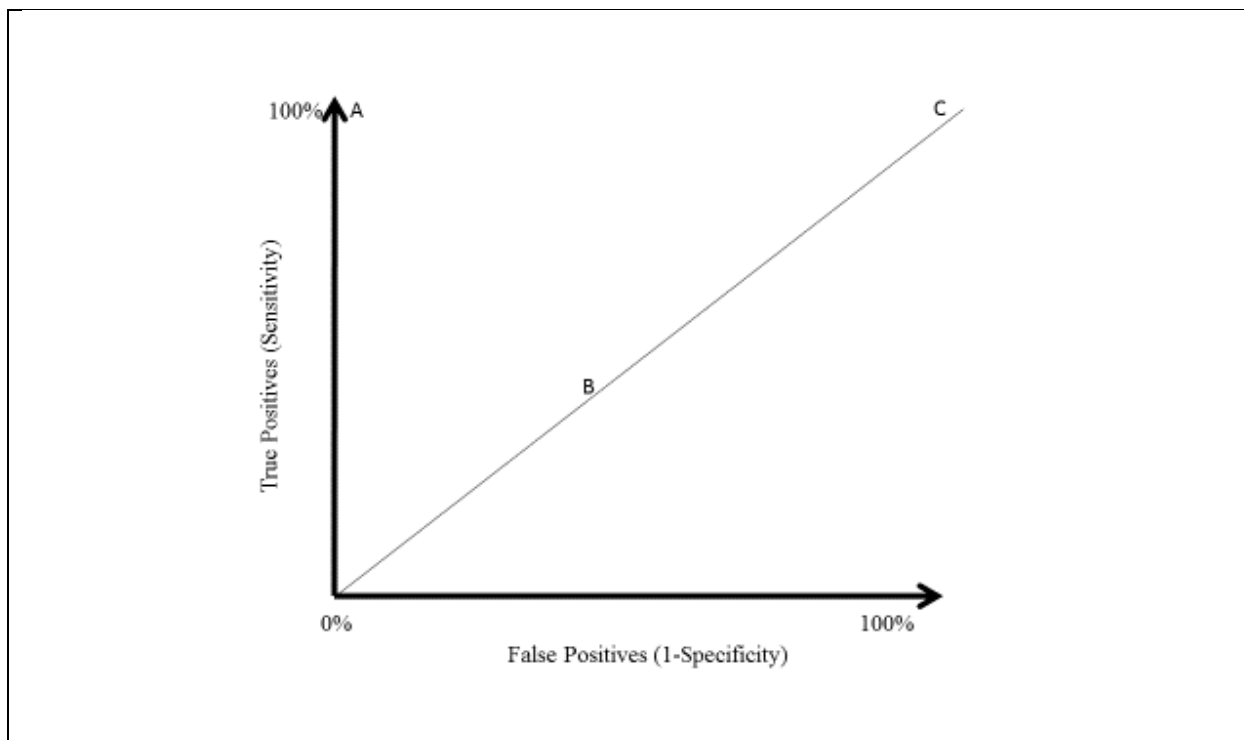
Figure 7: Interpreting the ROC Curve. Point *A* represents perfect prediction. It should actually be right against the Y-axis but is offset a little to make it visible. Point *B* represents random guessing, which is the case for anywhere along the bisecting line. Point *C* represents the "bluntest instrument possible" that gets perfect diagnosis but does so at the expense of the entire space. It is therefore actually as good as chance as well. The closer a model is to point A, the better the model, all else being equal.

Results

We can see that Bau Status variables by themselves add predictive value to the model (Table 5). Indeed all three kinds of variables – demographic, behavioral, and ecological are significant. The variables they contain are associated with the predicted category. Model 1 shows that that Non-Whites are more likely to be gang members and that women are less likely to be gang members than men. We also see that some of the parameters used to construct Blau space are associated with gang membership. Gang members tend to come from backgrounds of low SES, tend to score lower on academic aptitude, and have higher BMI. Model 2 shows that some of the behavioral variables are also associated with gang membership. Gang members are more likely to paint graffiti, engage in serious fights, engage in group fights, cause serious injury to

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someone, and sell drugs. Model 3 shows that being in a gang niche is strongly associated with being in a gang. Model 4 decomposed the Nicher effect into exclusive nichers and manifold nichers. While both are significant we see a very large effect from exclusive gang nichers.

Table 5. Logistic Regression of Gang Membership by Separate Predictor Types

	M1: Demographic		M2: Behavioral		M3: BS Niche		M4: BS Niche Type	
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Demographic Factors								
Grade (7th=ref)								
8th Grade	1.057	(0.180)						
9th Grade	0.973	(0.198)						
10th Grade	0.782	(0.237)						
11th Grade	0.544	(0.203)						
12th Grade	0.422*	(0.197)						
Race (White=ref)								
Black	1.648***	(0.215)						
Asian	1.639	(0.594)						
Other	2.465***	(0.464)						
Hispanic	2.509***	(0.322)						
Sex (Males=ref)								
Females	0.400***	(0.0367)						
BMI	1.045***	(0.0119)						
PVT	0.985***	(0.00367)						
Phys. Maturity	1.004	(0.0552)						
Age	1.018	(0.0713)						
SES	0.940***	(0.0190)						
Behavioral Factors								
Graffiti			1.505***	(0.101)				
Property Damage			1.029	(0.0689)				
Serious Phys. Fight			1.267***	(0.0710)				
Serious Injury Smn.			1.138*	(0.0790)				
Steal>$50			0.962	(0.0999)				
Threaten with Wpn.			0.994	(0.110)				
Sell Drugs			1.232***	(0.0676)				
Group Fight			1.788***	(0.120)				
Rowdy Public			1.059	(0.0603)				
Blau Statuses								

	(1)		(2)		(3)		(4)	
GangNicher					6.381***	(1.789)		
GangExclusive							34.93***	(12.23)
GangManifolder							5.855***	(1.574)
Constant	0.250	(0.252)	0.0236***	(0.00253)	0.0222***	(0.00447)	0.0222***	(0.00447)
Observations	11,710		11,724		11,844		11,844	
Pseudo R-squared	0.0705		0.134		0.0963		0.108	
Log Pseudolikelihood	-2096		-1950		-2076		-2049	
Wald Chi-Square	363.6		754.2***		43.70***		105.1***	

Note: Robust Standard Errors are in paranthesis. *** p<0.01, ** p<0.05, * p<0.1

Figure 8 presents the ROC curves and Table 6 compares the predictive robustness of the models. We can see that each model does a substantially better model than chance. The behavioral model appears to outperform all the others. The test of equality also demonstrates that the models are statistically different from one another.
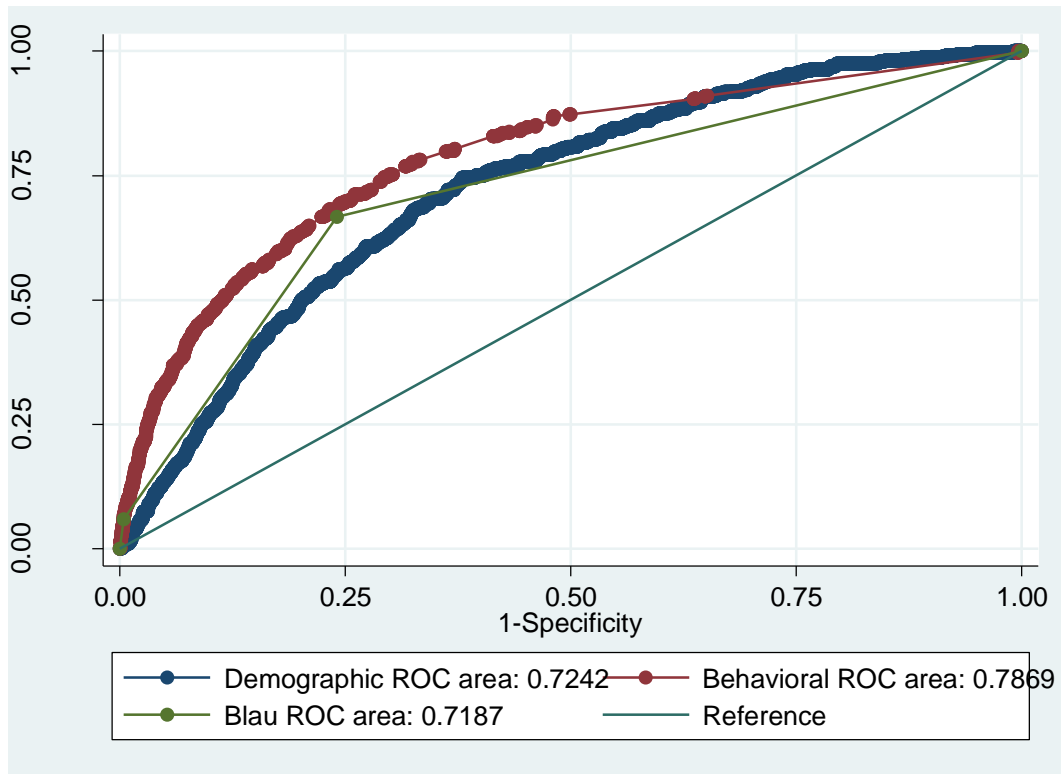
Figure 8: ROC Curves for Separate Models

Table 6: ROC Comparison of Separate Models

Model	ROC Area	SE
M1: Demographic	0.7242	0.0102
M2: Behavioral	0.7869	0.0106
M4: BlauDecomposed	0.7187	0.0105
Null Hypothesis: M1=M2=M3 ChiSq=26.00***		

Notes: *** p<0.01, N=11,590

Next, I consider combining each of the three factors with one another as well as into a single model (Table 7). We see that the effect of the Blau status variables survives in all the models, suggesting an autonomous value-added effect. Indeed the effect of exclusive nichers is the largest in all of the models. The effects of the other variables are also stable in the paired models as well as in the final model. This suggests that predicting recruitment into covert organizations may require all three types of factors.

Table 7. Logistic Regression of Gang Membership by Combined Predictor Types

	M6: Blau-Demog		M7: Blau-Behavioral		M8: Demog-Behaiv		M9: Omni	
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Demographic Factors								
Grade (7th=ref)								
8th Grade	0.882	(0.150)			1.014	(0.181)	0.858	(0.148)
9th Grade	0.673**	(0.134)			0.943	(0.200)	0.664*	(0.139)
10th Grade	0.475***	(0.135)			0.789	(0.217)	0.497**	(0.136)
11th Grade	0.346***	(0.114)			0.577*	(0.180)	0.384***	(0.115)
12th Grade	0.330***	(0.141)			0.459*	(0.191)	0.378**	(0.152)
Race (White=ref)								
Black	1.519***	(0.201)			1.488***	(0.189)	1.382**	(0.190)
Asian	1.209	(0.369)			1.530	(0.502)	1.159	(0.327)
Other	2.246***	(0.394)			1.970***	(0.390)	1.915***	(0.361)
Hispanic	1.997***	(0.268)			1.998***	(0.262)	1.643***	(0.215)
Sex (Males=ref)								
Females	0.392***	(0.0379)			0.552***	(0.0515)	0.525***	(0.0518)
BMI	1.070***	(0.00902)			1.043***	(0.00983)	1.069***	(0.00752)
PVT	0.990**	(0.00393)			0.984***	(0.00415)	0.988***	(0.00440)
Phys. Maturity	1.014	(0.0631)			0.998	(0.0607)	1.005	(0.0642)
Age	1.088	(0.0740)			0.986	(0.0584)	1.050	(0.0635)
SES	0.948**	(0.0199)			0.933***	(0.0219)	0.939***	(0.0204)
Behavioral Factors								
Graffiti			1.439***	(0.106)	1.401***	(0.0972)	1.372***	(0.104)
Property Damage			1.076	(0.0687)	1.079	(0.0774)	1.111	(0.0774)
Serious Phys. Fight			1.288***	(0.0713)	1.164***	(0.0634)	1.192***	(0.0647)
Serious Injury Smn.			1.104	(0.0776)	1.108	(0.0740)	1.069	(0.0715)
Steal>$50			0.942	(0.101)	0.986	(0.0972)	0.974	(0.103)
Threaten with Wpn.			1.017	(0.103)	0.973	(0.101)	0.992	(0.102)
Sell Drugs			1.223***	(0.0811)	1.271***	(0.0699)	1.228***	(0.0817)
Group Fight			1.723***	(0.112)	1.621***	(0.116)	1.590***	(0.112)
Rowdy Public			1.051	(0.0583)	1.166***	(0.0679)	1.157**	(0.0669)

Blau Statuses

GangExclusive	28.38***	(10.62)	32.65***	(11.54)			26.63***	(9.686)
GangManifolder	5.920***	(1.611)	5.207***	(1.383)			5.476***	(1.461)
Constant	0.0195***	(0.0249)	0.0111***	(0.00222)	0.171*	(0.161)	0.0161***	(0.0186)
Observations	11,710		11,724		11,590		11,590	
Pseudo R-squared	0.165		0.221		0.172		0.253	
Log Pseudolikelihood	-1882		-1755		-1829		-1651	
Wald Chi-Square	471.0***		961.6***		1491***		1808***	

Note: Robust Standard Errors are in paranthesis. *** p<0.01, ** p<0.05, * p<0.1

Figure 9 presents the ROC curves and Table 8 compares the predictive robustness of the models. We can see that each model combined does substantially better than by itself. The omni model appears to outperform all the others. The test of equality also demonstrates that the models are statistically different from one another. The combined models support the claim that considering Blau statuses in addition to other variables can results in powerful tools to uncover members of covert networks.
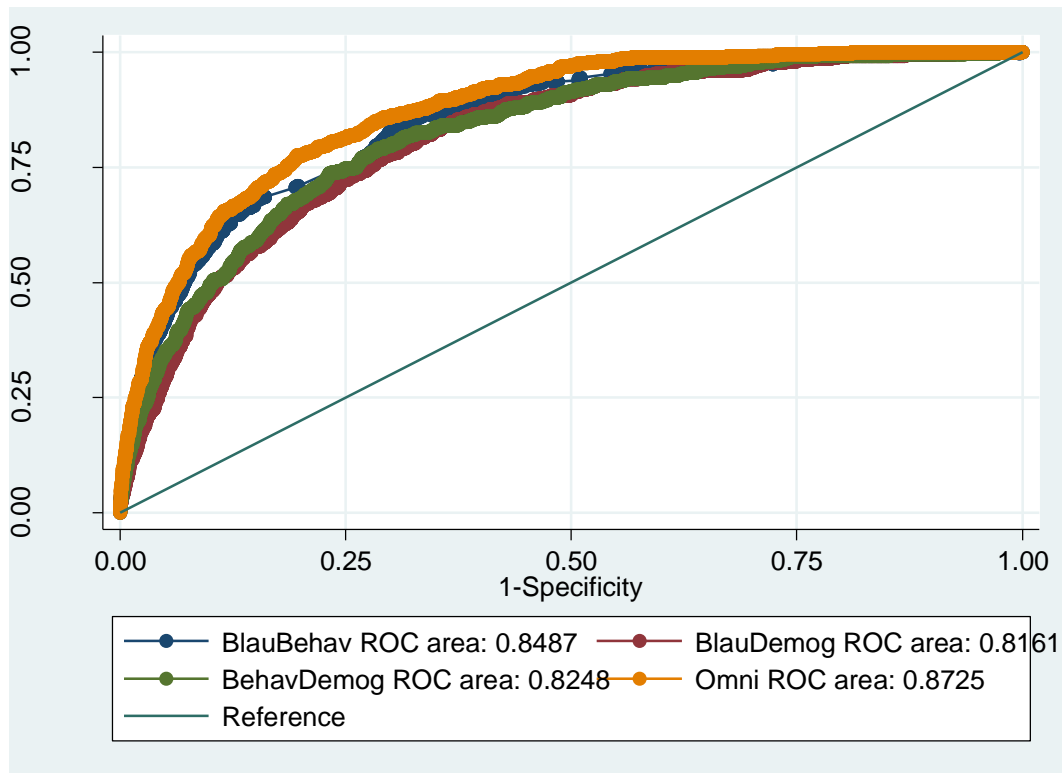

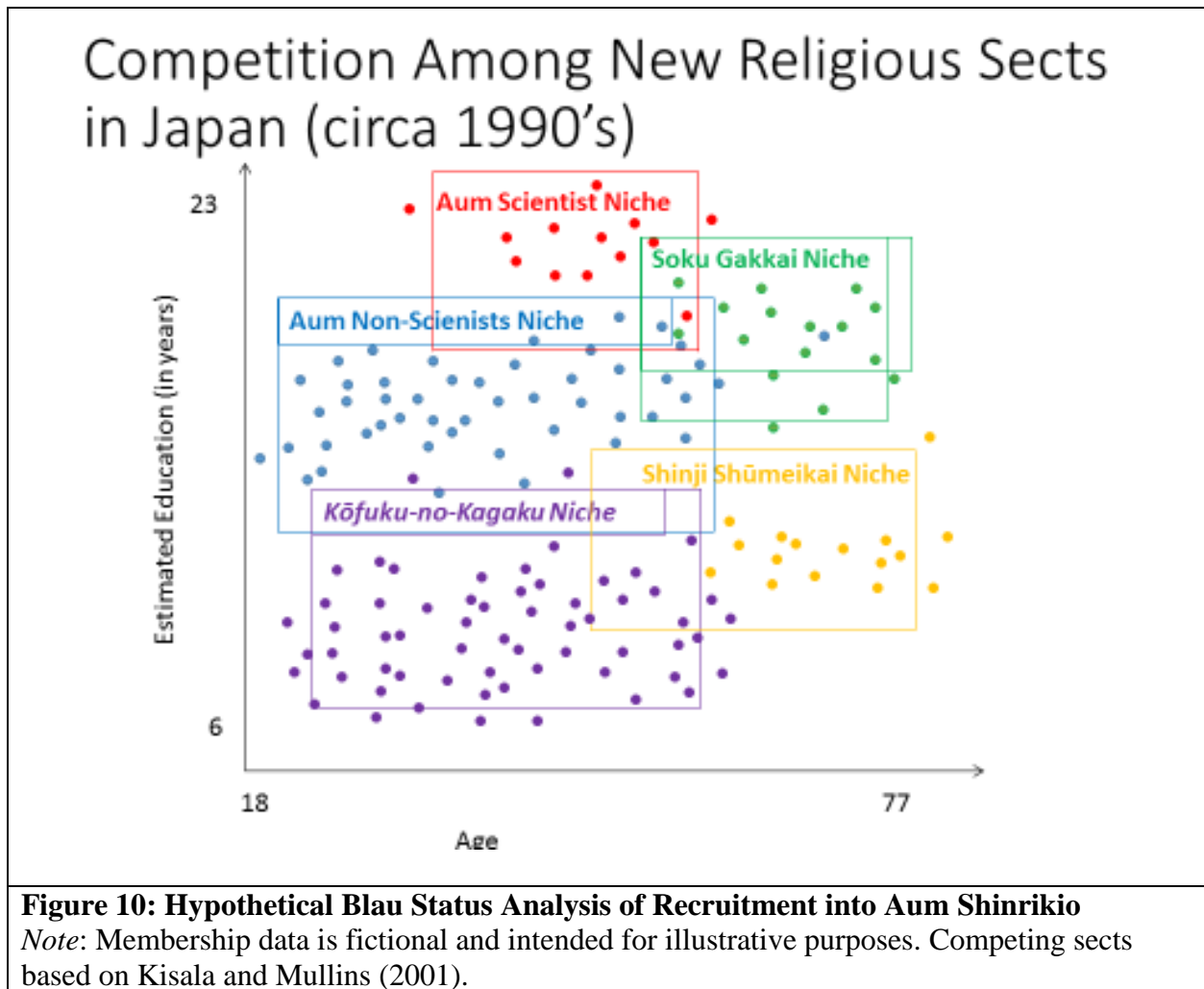**Figure 9: ROC Curves for Combined Models**

Table 8: ROC Comparison of Separate Models

Model	ROC Area	SE
M5: Blau-Behavioral	0.8487	0.0082
M6: Blau-Demographic	0.8161	0.0085
M7: Behavioral-Demogaphic	0.8248	0.0085
M8: Omni	0.8725	0.0068
Null Hypothesis: M1=M2=M3=M4 ChiSq=522.00***		

Notes: *** p<0.01, N=11,590

The evidence presented here shows that Blau statuses are predictive of membership in covert organizations especially when combined with other factors. Why are they predictive? Recall that organizations recruit members from a localized area of Blau space. In the case of the gangs in Add Health the area has relatively few competitors. This may suggest that covert or criminal organizations recruit from areas in social space where few other organizations recruit from. In practice the application of which area to focus on may depend upon the motivational type of the terrorist organization. Religious groups such as Aum Shinrikio recruited from the same pool of people as other sects in Japan (Kisala and Mullins 2001). Revolutionary groups may recruit from the same pool as political advocacy organizations. For example right-wing terrorists may compete for members with non-violent right-wing groups and left-wing terrorists may compete for members with non-violent left-wing groups. So the ecology may be tuned depending on the group. Indeed it may be possible to approximate the parameters of the terrorist group's niche (as far as the means and standard deviations) based on competitors. Figure 10 presents a hypothetical recruitment space in two dimensions (Age and Education) among the member of Aum Shinrikio and competing new religious organizations. We can see a sizable space around the age range of 23-35 and education range of 19-23 years. Combined with other information such as behavioral and demographic as well as a richer parameter space composed of more than two parameters, the method developed here suggests that we may be able to much more accurately predict of who will join covert groups such as Aum Shinrikio.

Figure 10: Hypothetical Blau Status Analysis of Recruitment into Aum Shinrikio
Note: Membership data is fictional and intended for illustrative purposes. Competing sects based on Kisala and Mullins (2001).

Testing such a proposition would require a full membership roster of a terrorist organization and information on the memberships of similar persons from the same ecology. If we had data on the individuals who joined al-Qaeda from a small Moroccan town, matched controls from the same town, and the organizations active in that town – we can test the proposition more thoroughly[79]. This kind of dataset is extremely difficult to collect but may be a research direction that will prove highly fruitful. The biggest contribution of the method is that unlike conventional profiling it allows for highly non-linear configurations of the dimensions to

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[79] I have spent a considerable effort in organizing a coding project that sought to gather this information on the members of the Japanese group - Aum Shinrikio. However, because of language barriers and the location of most of the primary sources in Japan the project was curtailed.

be included.

I would like to end by offering some reflection on the civil liberties aspects of this research. With the growth of the National Security State after WWII and after 9/11 terrorist attack as well as the revelations from the NSA spying scandal Americans are understandably worried about invasions of privacy by the government. A concern that my research raises is that it will contribute to unwarranted surveillance and the arrest of innocent people. However, I do not believe the concern is warranted.

First, security agencies view their primary mission as "catching bad guys". They will continue to do so with the tools they have at their disposal, no matter how crude. The demand for action from the public grows after an attack as we have seen with the passage of the Patriot Act. The tool I am developing is more refined, will result in less innocent people being wrongly accused, and more of the bad guys being uncovered quickly. From a pragmatic perspective I think it is in the interest of both national security and civil liberties that whatever tools are deployed, that they minimize false positives and maximize true positives. Given that I am proposing a diagnostic tool, a medical analogy is insightful. All cancer therapies wind up having side effects that are harmful to the patient's health. However, a patient with cancer is desperate and will consent to use whatever therapy has the potential to save him. We do not criticize scientists who develop therapies that have deleterious side-effects if the new therapy is more effective on balance than what we currently have. I would submit that the same thinking should apply to instruments for diagnosing terrorists. To continue the analogy, just as more violent tools may be used to fight cancer the further it has progressed and the more desperate the patient becomes, catching it early may save everyone the trouble of using more extreme measures. Developing more effective counter-terrorism tools is actually in the interests of the civil-libertarian because it avoids us getting to a stage where the need for more extreme actions is

contemplated.

Second, a more invidious argument is that the government may apply the tool to groups that are not actually violent radicals who systematically target civilians but are peaceful political dissidents. This is a serious concern, primarily outside the United States, but I would point out that every scientific advance is double-edged. Scientific ideas that advance human civilization have the power to set it back. This is the case for social science as much as it is for basic science[80]. The record for humanity thus far has been that the benefits of developing knowledge outweighed the imagined risks as well as the actual costs. It is my belief that this trend will continue.

Finally, it should be noted that the method proposed here is not a method to make point predictions of who is and isn't a terrorist. No reasonable court in the United States will ever convict a person of being a member of a terrorist organization on the basis of Blau Status Analysis. The method is meant to identify individuals at risk and the usual additional evidence should be gathered for any action that will infringe upon that person's liberties.

Discussion

This chapter focused on the ecology of organizational affiliation. The first part laid out a theoretical tool called Blau Status Analysis that extended affiliation ecology to individuals and their behaviors. The second part tested a particular Blau status, the manifolder in explaining features of network topology. The final part applied the framework to explaining recruitment into covert organizations.

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[80] Social Network Analysis is one such clear example with its use for military applications.

Moreover the Blau status argument provides further evidence to a long sociological insight – that external processes may endow seemingly innate attributes to individuals and that these attributes are relationally contingent (Emirbayer 1997) rather than intrinsic. The big promise of Blau Statuses is that it allows one to systematically model source of causal efficacy to higher-level dependencies. This follows the trajectory of social network analysis, where we have advanced from independent actors to dyads to ego networks to full networks to multi-modal network. Niches that are extended as a result of organizational competition form another layer of complexity that can be profitably analyzed.

Future Directions

There are a number of future directions for the Blau Status Research Program. In the second section I have tested a very small number of Blau statuses. I am interested in considering additional Blau Statuses and their potential to explain network properties and behavioral outcomes. For example individuals who are outsider-isolates (both outsiders in Blau Status and isolates in the network sense of having no social ties). Such persons may be especially vulnerable and it may be productive to look at such person as far as targets of bullying or other violence. We further believe that one aspect that is of particular interest is Non-niche membership – who are individuals that are members of an organization but are atypical such that they fall outside the niche. My intuition is that such persons may be the most ardent supporters of the cause – because they insecure and hope to prove themselves. For example Muslim converts in Muslim terrorist organizations and members of the Basque separatist group who were only half-Basque are anecdotally said to be more zealous than other members (Benjamin 2007; Bloom 2005). A very important aspect of Blau Statuses is the competition coefficient which may explain certain behaviors at the network level. It may be that ecologies with a high competition coefficient have

a higher level of centralization for example.

Lastly one exciting prospect of the paper is purely methodological. If it turns out that certain Blau Statuses are extremely correlated with network characteristics than one may use the former as a proxy for the later, when network information is not available. Affiliation analysis is much less data-intensive than network analysis.

Conclusion

Human societies are becoming organization societies. Groups and organizations dominate our lives and our time. But the joining of such organizations is neither entirely deliberate nor haphazard. Organizations visibly compete with one another for members. We argue that this competitive dynamic has not been sufficiently explored, especially in regards to individual-level behavior. This paper suggests a framework of how to think of this competition in terms of the kinds of statuses that the competed-over persons get sorted into, which we call Blau Statuses. We then show how these Blau Statuses systematically affect network dynamics and can be applied to predict affiliation in covert networks. Our hope is that our theoretical apparatus will contribute in a major way to long-standing sociological questions.

Appendix

Package 'blaunet'

January 15, 2014

Version 1.0.0

Date 2015-1-15

Title Calculate and Analyze Blau statuses for measuring social distance

Depends network (>= 1.7.1)

Description An integrated set of tools to calculate and analyze Blau statuses quantifying social distance between individuals belonging to organizations. Blaunet works by considering individuals placed in an abstract social space, defined by various user-provided variables. Organizations recruit from an area (or "niche") in social space. Blaunet analyzes where organizations recruit from, the positions users occupy in this competitive environment, and substantial features of the connections between individuals.

License GPL-3

URL http://csnp.soc.cornell.edu/

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Needs Compilation no

Repository CRAN

Date/Publication 2014-1-15 15:04:48

R topics documented:

GETTING STARTED

1. Purpose of software: The purpose of the software is to perform Blau status analysis, which is an analytic framework that allows one to describe how organizational competition affects micro-level processes. It relies on abstractly conceptualizing individuals as inhabiting a k-dimensional euclidean space formed by k variables.

2. Definitions:

a. Blau Space: A k-dimensional space, where socio-demographic characteristics such as age, years of education, or income are used to structure the dimensions of the space. These characteristics are referred to as Blau parameters. Individuals are then populated in this space based on their attributes on the specified demographic dimensions. Each person is represented by a set of k coordinates, which correspond to the person's attributes on the Blau parameters.

c. Niche: The area of the Blau space from which organizations recruit members. The niches are calculated based on the Blau parameters of individuals already in the organization. Organizations compete with each other both by recruiting members already inhabiting their niches and by expanding their niches. The extent to which niches overlap reflects competition between organizations for members. The niche for an organization is a hypercube in k-dimensional space.

d. Blau Status: Denotes a person's (or a relationship's) position in the organizational competitive ecology relative to the competing niches. Blau statuses that characterize a person's position in the ecology are called nodal blau statuses. Computing nodal statuses only requires membership information. Blau statuses that characterize a relationship's position in the ecology

are called dyadic blau statuses. Computing dyadic statuses requires not only membership, but also sociometric network information.

e. Ecology: A relatively bound system where organizations compete for members. The system is bound by spatial or other considerations. For example, a school where extracurricular clubs compete for members could represent a single ecology. A second school in another town may form a second ecology, as the second schools clubs do not recruit at the first school. A town where different voluntary organizations compete for members can also represent a single ecology. By assumption, organizations can only compete within an ecology. For instance, an Elks group can compete with a church group so long as the two draw members from the same community. However, much like the boundary specification problem (Laumann, Marsden, Prensky 1983) in social networks, ecologies are difficult to precisely define.

References:

Brashears, E. Matthew, Michael Genkin, and Chan S. Suh. "In the Organization's Shadow: How Individual Behavior is Shaped by Organizational Leakage"

Genkin, Michael, Matthew E. Brashears, and Chan S. Suh "Why Social Networks Differ: The Role of Organizational Competition"

McPherson, J.Miller. (2004). A Blau space primer: prolegomenon to an ecology of affiliation. Industrial and Corporate Change, 13(1), 263-280.

McPherson, J. Miller. (1981). A dynamic model of voluntary affiliation. Social Forces, 59(3), 705-728.

Data Structure

Several types of information are necessary or helpful to specific the Blau statuses of individuals:

b) Individual ID: this variable identifies the individuals in the dataset

a) Ecology ID: indicates how individuals are partitioned into ecologies (e.g. schools, cities, etc.).

c) Blau Parameters: continuous demographic characteristics of individuals that the researcher finds relevant to determining similarity among individuals (e.g. age, SES, BMI). This set of variables is used to construct the niches that structure Blau space.

d) Organizational Memberships: the membership of individuals in specific organizations (e.g. charitable organizations, religious groups, fraternal organizations). This set of variables is used to construct the niches that individuals occupy.

e) Network data: the sociometric network information of individuals. This information is used to compute dyadic blau statuses, although is not necessary for other status computations.

f) Weights (optional): for data that was sampled from a population and where Blau parameters need to be adjusted by weights.

function: blau

1. TITLE

    a. Converts raw data into an object for Blau status analysis

2. DESCRIPTION

    a. Converts a matrix of organization memberships and demographic dimensions, along with (optionally) an edgelist or adjacency matrix, into an object of class **blau**. Automatically detects organization membership and demographic columns.

3. ARGUMENTS

    a. square.data—R matrix or data.frame object that must contain demographic and membership information (in columns). May also include columns of individual or ecology identifiers, weights, or a primary membership column.

    b. graph—a named edgelist or adjacency matrix. This is required for computing measures which incorporate network information. Relies on the **network** object from package **network**.

    c. directed.el—defaults to FALSE. Used only to indicate whether an edgelist passed to this function should be treated as directed or undirected. Not necessary if passing an adjacency matrix.

    d. node.ids—Indicates the column which holds node (individual) identifiers. May be the column number or column name.

    e. ecology.ids—Indicates the column which holds ecology identifiers. May be the column number or column name.

    f. dimensions—Indicates the columns which hold Blau parameter information. May be a vector of column names as strings, or a vector of column numbers. In the absence of specification, all non-binary columns that are not used for other

purposes will be assumed to be demographic variables.

g. memberships—Indicates the columns which hold organizational membership information. May be a vector of column names as strings, or a vector of column numbers. In the absence of specification, all binary columns that are not used for other purposes will be assumed to be membership indicators.

h. weights—A column with weights for each observation. May be the column number or column name. In the absence of specification, all weights are assumed to be equal (and are set to 1). Weights are used in a weighted standard deviation calculation.

i. exclude—A way to manually exclude columns from automatic incorporation as membership or demographic columns. May be a vector of column names as strings, or a vector of column numbers. Useful for larger datasets where the vast majority of columns are included.

j. complete.cases—Defaults to FALSE. A boolean setting indicating whether all rows with at least one missing value should be dropped before proceeding with calculations. Otherwise, the program will be "greedy" about determining niche boundaries, using as much information as possible.

4. DETAILS

a. The most common raw data format is a csv file that contains ecology identifiers, node identifiers, blau parameters, and memberships, among other variables

b. The vast majority of configuration takes place when calling the **blau** function. As such, it is essential that the user understand how choices made here impact the operation of subsequent functions. The easiest way to get started is to determine

which of the four optional parameters—node identifiers (node.ids), ecology identifiers (ecology.ids), weights (weights), and relational data (graph)—are present in your dataset and will be used for analysis. These should be specified by indicating their locations with the appropriate function argument, and the **blau** function will automatically assume all other columns are either membership or demographic columns. If there are columns to be excluded from analysis, they can be specified with the exclude parameter. This type of setup is appropriate for the vast majority of datasets.

c. It is important to remember that any information incorporated into the blau object through this function will be used when calling subsequent functions. For instance, if your analysis does not require weights, but they are provided in the dataset, they should be explicitly excluded with the exclude argument.

d. If ecology identifiers are provided, all subsequent analyses will automatically proceed on a by-ecology level (unless specified explicitly in subsequent functions).

e. With network information, the most important consideration is that node identifiers are properly indicated and may be matched up with node identifications provided with the node.ids parameter. Adjacency matrix or edgelist input formats are both converted to an sna.edgelist object. The preferred format is a named edgelist (two columns, with node names in each row indicating an edge).

f. If node names are numeric rather than character, they should still be specified in the input function with node.ids and a network should correctly indicate node identifiers.

g. If complete.cases is FALSE (the default option), we automatically use as much

information as possible to compute niche boundaries. For example, an individual

may have missing Blau parameter information for a certain dimension. Under the

default settings, we still utilize the user's other demographic information to

compute niche boundaries. If compleCases is specified as TRUE, then only

observations with no missing values along all elements in the input matrix will be

utilized in determining boundaries.

5. VALUE

    a. Returns an object of class **blau**. This is an R list with several elements, which

       provides an easy way to pass all relevant information to subsequent functions.

       Elements may be inspected with the "$" operator, but should not be directly

       modified by the user. Doing so can cause unexpected behavior.

    b. $ids—a two column matrix containing node and ecology identifiers, respectively.

       Defaults to assigning a number from 1 to n for each node, and giving all

       individuals the same ecology (equal to 1).

    c. $memberships—Columns of binary variables indicating which individuals are

       members of which groups or organizations.

    d. $dimensions—Columns of non-binary variables indicating individuals'

       characteristics along dimensions.

    e. $weights—A column indicating the weight value for each individual to be

       incorporated into a weighted standard deviation calculation. Defaults to a column

       of 1's.

    f. $isInNiche—Initialized to NULL. A placeholder for the output of the niches

       function.

    g. $topbounds—Initialized to NULL. A placeholder for the output of the niches

function.

h. $lowbounds—Initialized to NULL. A placeholder for the output of the niches

function.

i. $nodalLocal—Initialized to NULL. A placeholder for the output of the

nodal.local function.

j. $nodalGlobal—Initialized to NULL. A placeholder for the output of the

nodal.global function.

k. $nodalNetwork—Initialized to NULL. A placeholder for the output of the

nodal.network function.

l. $dyadic—Initialized to NULL. A placeholder for the output of the dyadic

function.

6. EXAMPLES

a. basic example with TwoCities, no network

    i.   data(TwoCities)

    ii.   b <- blau(TwoCities, ecology.ids = "samp")

    iii.   #compute organizational niches

    iv.   b <- niches(b)

    v.   #see active elements

    vi.   print(b)

    vii.   #compute global blau statuses

    viii.   b <- nodal.global(b)

b. more advanced example excluding cols, no network

    i.   #assume we don't care about the "ideo" column

    ii.   b <- blau(TwoCities, ecology.ids = "samp", exclude = "ideo")

        iii.   # compute niches like before

        iv.   b <- niches(b)

c. basic example with network

        i.   data(BSANet)

        ii.   b <- blau(BSANet, node.ids = "person", ecology.ids = "city", graph =

           BSAel)

        iii.   #compute dyadic statuses

        iv.   b <- dyadic(b)

function: niches

1. TITLE

   a. Locate individuals in organizational niches in Blauspace

2. DESCRIPTION

   a. Takes an object created with function **blau** and locates individuals in organizational niches. Automatically handles multiple ecologies by performing niche calculations separately for each ecology.

3. ARGUMENTS

   a. blauObj—an object created with the function **blau**.

   b. dev.range—Defaults to 1.5. When creating niches, indicates standard deviation around the mean in each dimension to include in niche. A larger value will make niches larger and therefore include more individuals.

   c. ecologies.off—defaults to FALSE. If set to TRUE, treats all individuals as in the same ecology, even if ecology identifiers (ecology.ids) have been specified.

4. DETAILS

   a. Creates niches for each organization within each ecology. Niches are hypercubes in euclidean space that define the area a member-seeking organization is likely to recruit members from. Consider a given organization: its members have various traits such as age, income, and work experience. We find the mean point in n-dimensional space for an organization. For each dimension, we extend **dev.range*SD** out from this mean in both positive and negative directions. Doing this for each dimension defines the niche for the given organization within the given ecology. The default **dev.range** is 1.5.

   b. Once we define niche dimensions, we examine the demographic information for

each individual and indicate whether the individual is inside the niche. This information is stored in the matrix **$isInNiche**.

    c. Each ecology may have different niche boundaries for a given organization. This heterogeneity is important for examining how different organizations recruit in different ecologies (e.g. cities, schools, etc.).

5. VALUE

    a. topbounds—upper boundaries of each dimension, for each niche, within each ecology. Access with the $ operator.

    b. lowbounds—low boundaries of each dimension, for each niche, within each ecology. Access with the $ operator.

    c. isInNiche—matrix that indicates whether each individual falls within each niche within a given ecology. Contains a number of columns equivalent to the number of organizations. A column of ecology identifiers is appended to the right.

6. EXAMPLES

    a. data(TwoCities)

    b. b <- blau(TwoCities, ecology.ids = "samp")

    c. #compute niches

    d. b0 <- niches(b)

    e. #change std. dev used for calculating niches

    f. b1 <- niches(b, dev.range = 1.0)

    g. #treat everyone as members of one ecology

    h. b2 <- niches(b, ecologies.off = TRUE)

function: print

1. TITLE

    a. Quick summary of blau object.

2. DESCRIPTION

    a. Identifies measures that have been computed.

3. ARGUMENTS

    a. blauObj—an object of class **blau** initialized with the function **blau**.

4. DETAILS

    a. Since measures computed with many functions are stored in the **blau** object itself,

    it is helpful to quickly see which elements are active.

5. VALUE

    a. A string indicating the active elements.

6. EXAMPLES

    a. data(TwoCities)

    b. b <- blau(TwoCities, ecology.ids = "samp")

    c. b <- niches(b)

    d. print(b)

function: summary.niche

1. TITLE

    a. Summarizes information on each membership organization.

2. DESCRIPTION

    a. Aggregates information on each organization and returns five summary measures—the number of individuals in the organization, the number of individuals in the organization's niche, the number in the organization but not in the niche, the number of individuals exclusively in the niche, and the number of individuals who overlap with other niches.

3. ARGUMENTS

    a. blauObj—an object of class **blau** initialized with the function **blau**. The function **niches** must have been called previously by the user.

4. DETAILS

    a. The purpose of this function is to get a better sense of how the niches are organized within each ecology.

    b. The rows represent niches. The number of rows corresponds to the number of niches.

    c. OrgMem: computes how many people are in each of the organizations that structure the niche.

    d. NicheMem: computes to how many people are in each of the niches

    e. NichExc: computes how many people are exclusive to that niche and only to that niche (not in any other niche);

    f. NicheOvr: computes how many people are in 2 or more niches

    g. MemExc: computes how many people are in the organization but not in the organization's niche. This happens because they are outside the demographic boundaries of the set standard deviations that are used to define the niche.

5. VALUE

    a. Returns an object of class **data.frame** that contains the five summary measures as columns, along with two columns identifying the ecology and the niche corresponding to the information provided.

6. EXAMPLES

    a. data(TwoCities)

    b. b <- blau(TwoCities, ecology.ids = "samp")

    c. b <- niches(b)

    d. niche.summary <- summary.niche(b)

function: summary.ecology

1. TITLE

    a. Summarizes the distribution of individuals across niches.

2. DESCRIPTION

    a. Outputs a niche-by-niche matrix for each ecology where each cell, [A,B], corresponds to the number of individuals who are in both niche A and niche B. Diagonal elements, [A,A], contain the number of individuals exclusively in ecology A.

3. ARGUMENTS

    a. blauObj—an object of class **blau** initialized with the function **blau**. The function **niches** must have been called previously by the user.

    b. percent—

4. DETAILS

    a. The purpose of this function is to give the analyst a sense of the structure of the ecology. At one extreme the niches may be completely overlapping and at the other the niches may be completely separate. The former condition suggests fierce competition, whereas the later suggests strong localization. A situation in the middle indicates a particularly interesting competitive situation.

5. VALUE

    a. Returns an object of class **data.frame** that contains a niche-by-niche matrix for each ecology. Ecology and niche identifiers are presented in the first two columns, followed by the niche-by-niche matrix. Matrices are stacked vertically.

6. EXAMPLES

a. data(TwoCities)

b. b <- blau(TwoCities, ecology.ids = "samp")

c. b <- niches(b)

d. ecology.summary <- summary.ecology(b)

function: nodal.global

1. TITLE

    a. Compute Blau statues for individuals across all niches.

2. DESCRIPTION

    a. Computes three measures—total number of organizations the individual occupies, total number of niches a person occupies, and a string indicating the niches an individual occupies.

3. ARGUMENTS

    a. blauObj—an object of class **blau** initialized with the function **blau**. Individuals will automatically be placed in niches with the function **niches** if this has not been done manually.

    b. dev.range—Defaults to 1.5. When creating niches, indicates standard deviation around the mean in each dimension to include in niche. A larger value will make niches larger and therefore include more individuals.

    c. ecologies.off—defaults to FALSE. If set to TRUE, treats all individuals as in the same ecology, even if ecology identifiers (ecology.ids) have been specified. Will call the **niches** function and overwrite its output even if it has been manually called by the user.

4. DETAILS

    a. The three measures computed provide information on each individual across all niches.

    b. TotalOrgs: Total number of organizations the person is in. The lower bound is 0 and the upper bound is the maximum number of organizations in the ecology.

    c. Nicher: Provides information on how many niches the person is in or how many

organizations are competing for that individual (irrespective of actual membership). The value of 0 indicates that a person in an outsider (is not in any niche). The value of 1 indicates that the person is an exclusive nicher, suggesting an organizational monopoly. A value of 2 or more indicates that the person is a manifolder or belongs to multiple niches and is a potential recruit for multiple organizations.

d. Niches: a string indicating which niches the individual belongs to and containing niche column numbers separated by spaces. This provides an at-a-glance format and may be easily split up with string parsing functions.

5. VALUE

a. A matrix object stored in **$nodalGlobal** that contains the three measures in three columns. Row names are node names provided with the **blau** function.

6. EXAMPLES

a. data(TwoCities)

b. b <- blau(TwoCities, ecology.ids = "samp")

c. #will automatically call niches

d. b0 <- nodal.global(b)

e. #treat all individuals as in same ecology

f. b1 <- nodal.global(b, ecologies.off = TRUE)

function: nodal.local

1. TITLE

    a. Computes Blau statuses for individuals with respect to a primary membership.

2. DESCRIPTION

    a. Computes two measures: whether an individual is within the niche of the primary membership specified, and whether the individual is a member of the primary membership but outside of that membership's niche.

3. ARGUMENTS

    a. blauObj—an object of class **blau** initialized with the function **blau**. Individuals will automatically be placed in niches with the function **niches** if this has not been done manually.

    b. FocalNiche—Specifies a primary membership by name of the organization.

    c. dev.range—Defaults to 1.5. When creating niches, indicates standard deviation around the mean in each dimension to include in niche. A larger value will make niches larger and therefore include more individuals.

    d. ecologies.off—defaults to FALSE. If set to TRUE, treats all individuals as in the same ecology, even if ecology identifiers (ecology.ids) have been specified. Will call the **niches** function and overwrite its output even if it has been manually called by the user.

4. DETAILS

    a. This provides information about the focal membership for each individual.

    b. FocNicher: Provides information on how many niches a person is in including the focal niche (it may also be accessed manually by **$isInNiche**). A value of 0 indicates a person is not in any niche. A value of 1 indicates the person is only in

the focal niche. A value of more than 1 indicates the person is in more than the focal niche. **((it may be more intuitive if we use two columns: in prim mem and total # niches))**

    c. MemNotNiche: indicates whether an individual is a member of the focal membership but outside of the focal niche. This indicates that an individual is atypical compared to other group members.

5. VALUE

    a. A matrix stored in **$nodalLocal** with two columns, each containing one of the two measures. Row names are node names provided with the **blau** function.

6. EXAMPLES

    a. data(TwoCities)

    b. b <- blau(TwoCities, ecology.ids = "samp")

    c. #will automatically compute niches

    d. b0 <- nodal.local(b, focalNiche = "grp_liberal")

function: nodal.network

1. TITLE

   a. Computes nodal spanners.

2. DESCRIPTION

   a. Computes whether an individual spans (has connections in) another niche and the number of other niches each individual spans to.

3. ARGUMENTS

   a. blauObj—an object of class **blau** initialized with the function **blau**. Individuals will automatically be placed in niches with the function **niches** if this has not been done manually.

   b. dev.range—Defaults to 1.5. When creating niches, indicates standard deviation around the mean in each dimension to include in niche. A larger value will make niches larger and therefore include more individuals.

   c. ecologies.off—defaults to FALSE. If set to TRUE, treats all individuals as in the same ecology, even if ecology identifiers (ecology.ids) have been specified. Will call the **niches** function and overwrite its output even if it has been manually called by the user.

4. DETAILS

   a. This function requires sociometric network data and identifies ties that bridge niches. The preferred format is a named edgelist, although an adjacency matrix with properly named rows and columns is also acceptable. Network information will be matched to organization and demographic information by these names.

   b. For individuals i and j in niches Alpha and Beta, if individual i is in niche Alpha and individual j is in niche Beta, and i and j have an edge between them, then i

spans to niche Beta and j spans to niche Alpha. However, if i is in both niche

Alpha and niche Beta, i would not span to Beta because i is already in niche Beta.

5. VALUE

    a. A matrix stored in **$nodalNetwork** with two columns holding the two measures.

        Row names are node names provided with the **blau** function.

6. EXAMPLES

    a. data(BSANet)

    b. b <- blau(BSANet, node.ids = "person", ecology.ids = "city", graph = BSAel)

    c. #will automatically compute niches

    d. b <- nodal.network(b)

function: dyadic

1. TITLE

    a. Computes dyadic Blau status measures.

2. DESCRIPTION

    a. Computes six dyadic measures (computed for each edge in the edgelist). They are

    Euclidean Distance, Mahalanobis Distance, Co-nichers, Co-outsiders, Straddlers, Spanners.

3. ARGUMENTS

    a. blauObj—an object of class **blau** initialized with the function **blau**. Individuals

    will automatically be placed in niches with the function **niches** if this has not been

    done manually.

    b. dev.range—

    c. ecologies.off—defaults to FALSE. If set to TRUE, treats all individuals as in the

    same ecology, even if ecology identifiers (ecology.ids) have been specified. Will

    call the **niches** function and overwrite its output even if it has been manually

    called by the user.

    d. m.dist—

4. DETAILS

    a. All measures are at the edge-level of analysis and characterize ties/dyads rather than

    individuals/nodes.

    b. Euclidean Distance: is the euclidean distance between two nodes in the edge

    c. Mahalanobis Distance: is euclidean distance standardized by the unit of measurement

    d. Co-nichers: are ties that are located within the same niche. A 0 indicates that both nodes of the tie

    do not share any niche in common. A 1 indicates that both nodes of the tie belong to only one

    common niche. A number of 2 or more indicates that the nodes of the tie share more than 1

    common niche.

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e. Co-outsiders: is an indicator variable that denotes ties where both nodes do not belong to any niche.

f. Straddlers: is an indicator variable that denotes ties where one node belongs to at least one niche and the other node does not belong to any niche.

g. Spanners: is an indicator variable that denotes ties where one node belongs to one niche and the other node belongs to a different niche

5. VALUE

a. Returns a matrix stored in **$dyadic** that contains eight columns. The first two contain the ego and alter for the edge, and the next six contain the dyadic measures.

6. EXAMPLES

a. data(BSANet)

b. b <- blau(BSANet, node.ids = "person", ecology.ids = "city", graph = BSAel)

c. #will automatically compute niches

d. b <- dyadic(b)

function: export.nodal

1. TITLE

   a. Outputs all node-level measures computed by the user.

2. DESCRIPTION

   a. Takes any output from nodal Blau functions (**niches**, **nodal.local**, **nodal.global**, or **nodal.network**) and presents it in one matrix for further analysis outside of Blaunet or output to disk.

3. ARGUMENTS

   a. blauObj—an object of class **blau** initialized with the function **blau**. User must have called at least one of the following functions: **niches**, **nodal.local**, **nodal.global**, or **nodal.network**. Otherwise, there is nothing to export.

   b. niches—defaults to TRUE. If TRUE, includes the full matrix of individuals located in niches as part of the output. This information may not always be desirable for output, and setting this to FALSE will prevent the full matrix of individuals located in niches from being included.

4. DETAILS

   a. This function is useful to manipulate the computed nodal Blau statuses and analyze them outside the blaunet program, either within R or by exporting them to another statistical package.

5. VALUE

   a. Returns an object of class **data.frame** that includes all output from **niches**, **nodal.local**, **nodal.global**, or **nodal.network** previously computed by the user. The user must manually call one or more of these four functions prior to calling **export.nodal**. Columns are labeled with the name of the measure. Row names are

node names provided with the **blau** function.

6. EXAMPLES

    a. data(TwoCities)

    b. b <- blau(TwoCities, ecology.ids = "samp")

    c. #blau object will store whatever you compute

    d. b <- nodal.global(b)

    e. b <- nodal.local(b)

    f. export.nodal(b) #will export global and local

    g. export.nodal(b, niches = FALSE) #suppress niche export

function: export.dyadic

1. TITLE

   a. Outputs dyadic level measures computed by the user.

2. DESCRIPTION

   a. Takes any output from dyadic blau functions (**dyadic)** and presents it in one

   matrix for further analysis outside of Blaunet or output to disk.

3. ARGUMENTS

   a.

4. DETAILS

   a. This function is useful to manipulate the computed dyadic Blau statuses and

   analyze them outside the blaunet program, either within R or by exporting them to

   another statistical package.

5. VALUE

   a.

6. EXAMPLES

   a. data(BSANet)

   b. b <- blau(BSANet, node.ids = "person", ecology.ids = "city", graph = BSAel)

   c. b <- dyadic(b)

   d. export.dyadic(b)

data: TwoCities

1. NAME: TwoCities

2. DESCRIPTION:

    a. The dataset contains 1008 individuals, their attributes on 4 demographic

    characteristics for constructing Blau parameters, and their memberships in 18

    voluntary organizations, as well as six other assorted variables.

3. DETAILS

    a. The dataset contains a sample of individuals from two cities in the United States:

    Bismarck, North Dakota and Grand Rapids, Michigan.

4. USAGE: (data) TwoCities. The R Object is a dataframe

5. List of TwoCities

Details

Memberships

grpsport Participate in sports club, league, or outdoor activity

grpyouth Participate in youth organization

grppta Participate in parent association or other school support group

grpvet Participate in veterans group

grpnei Participate in neighborhood association

grpeld Participate in seniors groups

grpsoc Participate in charity or social welfare organization

grplab Participate in labor union

grpprof Participate in professional, trade, farm or business org

grpfrat Participate in service or fraternal organization

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grpeth Participate in ethnic, nationality, or civil rights org

grppol Participate in political group

grpart Participate in literary, art, or musical group

grphob Participate in hobby, investment, or garden club

grpself Participate in self-help program

grpwww Involved in group that meets over the Internet

grpothr Belong to other kinds of clubs or organizations

Demographics

Educ: respondent education

Income: respondent income

Age: respondent age

Wrktime: respondent

Samp: community sample ecology

Other

Gender: Respondent gender

Race: Respondent Race

Ideo: Respondent Ideology

Trust: Whether most people can be trusted or...

Diversity: Diversity of Friendships

Friends: About how many CLOSE FRIENDS do you have these days?

This represents 29 variables out of the 407 variables in the full dataset.

6. SOURCE

a. The TwoCities dataset is excerpted with permission from the Social Capital Benchmark Survey, which was collected by Professor Robert D. Putnam of the Saguaro Seminar Civic Engagement in America, a project of the John F. Kennedy School of Government at Harvard University and numerous community foundations nationwide, and made available through the Roper Center for Public Opinion Research. The full data can be accessed at the Roper Center for Public Opinion website at the following url:

http://www.ropercenter.uconn.edu/data_access/data/datasets/social_capital_community_survey_2006.htm

data: BSANet

1. NAME: BSANet

2. DESCRIPTION:

    a. The dataset is a practice dataset created to illustrate the dyadic blau status functions of Blaunet.

3. DETAILS

    a. This dataset was created solely to illustrate the dyadic Blau status functions of Blaunet. It contains a data.frame with two small ecologies. Individuals can belong to either a liberal or conservative organization (or both). Information is provided on age, education, and income. Individuals exist within a network. We provide the network in both adjacency matrix and edgelist formats for illustrative purposes.

    b. Most real datasets that contain networks and memberships are proprietary and cannot be freely shared even as excerpts. Users who are interested in working with actual data are urged to consider the restricted version of the Adolescent Health Dataset, which contains demographic, membership, and socio-metric data: http://www.cpc.unc.edu/projects/addhealth/data/restricteduse

4. USAGE: (data). The R object is a list containing three data.frames. Elements may be accessed with the $ operator.

5. SOURCE:

    a. Data was created by the Blaunet team. All data is fictional and was created with a random number generator.

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CONCLUSION

The aim of this dissertation was to make a contribution on two levels. First, it aimed to contribute a unique theoretical understanding to the problem of terrorism and political violence. Second, it aimed to contribute to general social scientific knowledge by developing theories that applied beyond the substantive subject matter. This conclusion will elaborate on both themes.

Terrorism and political violence are endemic problems for human civilization. Like most social problems, only by understanding the phenomenon can we begin to develop sensible strategies to managing it. Recent attacks on the United States have especially attracted a large number of political scientists, psychologists, and other researchers to studying the problem. However, the phenomenon of political violence has not garnered as much attention among sociologists[81]. Some of this is due to lack of interest and some to suspicions that researching terrorism promotes reactionary politics. I have personally experienced and witnessed the hostility that some sociologists express toward colleagues who do terrorism-related work. None of the major journals of terrorism research, the editors of academic series on terrorism are sociologists. The area is generally "understudied" as one reviewer characterized the body of the sociological literature on the subject in the Annual Reviews of Sociology (Turk 2004). Terrorism or political violence topics rarely make it to the top journals of sociology. Searching the abstracts of the top three journals of sociology – *American Sociological Review*, *American Journal of Sociology*, and *Social Forces* for the keywords "terrorism" or "terrorist" or "political violence" produced just 9 hits for the period of 2001-2014. That is less than one article a year! By comparison, using the same search parameters, the keywords for the other subareas of the discipline: "inequality", "gender", "race", "health", "education", and "social networks" have produced 224, 199, 141,

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[81] There are some exceptions for highly visible works on such topics as revolution, ethnic riots, and repression but those are the exceptions rather than the rule.

136, 132, and 67 articles, respectively. Few sociologists are funded by federal agencies that seek to understand terrorism, though there are some notable exceptions. This concentration of a particular kind of expert on the problem of terrorism has imported a particular kind of theoretical bias in investigating it. One way this bias manifests itself is in the focus on the individual-level of analysis. This is a natural theoretical tendency – there is something different about persons who resort to arms and this difference is probably located in their psychological makeup. This individual-level approach has some utility but it ignores a number of insights that are central to sociology. Broadly speaking, I refer to these insights as the ecological approach, where the source for causal explanation rests in the environment of the actor. In particular the approach focuses on the larger system in which the actor is embedded as well as the dynamic interactions of the elements that constitute the system. The dissertation has applied this approach to three issues in particular: the diffusion of suicide bombing across the globe; the mobilization of self-starter terrorism, and the recruitment into terrorist organizations. Each explanandum rested in the larger system in which the actors were embedded – their culture, the larger network, and the competitive ecology.

One general insight that I would like to draw out is methodological. It is natural to try to understand terrorism by interviewing the terrorist. But terrorists often provide rationalizations rather than explanations that caused their actions (Bloom 2009). This is not unique to terrorism; human beings are bad judges of what drives their actions and introspection/interviewing is a deeply flawed instrument to uncovering causal forces (see a great discussion of this, in the May 2014 issue of *Sociological Methods and Research*). System-level accounts on the other hand are less intuitive. Looking at constructs such as culture, networks, or organizational affiliation is more difficult both theoretically as well as methodologically. But like the proverbial drunk, we must not let the light dictate where we should search for our keys. Indeed the ecological

approach calls for a major investment in data collection. The collection of data at the organizational-level that varies over time would be particularly useful. Intelligence agencies would be well-served to release data on non-existing terrorist organizations that they have collected but kept classified due to organizational inertia and norms of secrecy. Such data would allow scholars to test arguments at a much deeper level of granularity than what is available from the current data. Polling agencies such as Pew should attempt to gather network data when polling about radical opinions. Other data collection institutes should attempt to collect affiliation data. Network and affiliation data would allow researchers to consider causal forces far beyond the individual-level.

The other important insight has to do with the relationship between those who have an immediate need to understand political violence and those who are in a position to provide answers. Terrorism research should not become the province of political science, psychology, or any single discipline for that matter. Security-oriented funding agencies and the intelligence community should spend more effort in courting sociologists by making opportunities for grants and funding more widely known and available. Sociologists in turn should have an honest dialogue about the unwritten taboo that some in our profession hold about cooperating with government agencies who fund terrorism research[82]. For the distance between the two was not always so. The Department of War (pre-cursor to the Department of Defense) once had a Chief Sociologist and sociologists have made major contributions to the war effort during World War II (Odum 1951). In fact, the founder and first chairman of Cornell's Sociology and Anthropology Department[83] (1939) was the Chief Sociologist for the War Department – Leonard S. Cottrell

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[82] Needless to say, like any cooperation between the funding agent and the researchers strict ethical guidelines should always be followed. The commitment to uncovering truth is sacred. To this I would add that knowledge should, to the extent possible, not remain classified since the norm of public knowledge and the elimination of bad ideas through critical scrutiny that it produces, is critical to the success of science.
[83] And also Dean of the College of Arts and Sciences

(Odum 1951). The founders of Peace Studies were sociologists, Johan Galtung in particular (see Lawler 1995). But sociology's current drift away from the study of political violence has not only harmed students of political violence, it has – I would argue – harmed sociology itself. For ideas generated in the study of a specific subject matter are often relevant beyond it. This was especially true of the old researchers in military sociology. The most obvious example was Samuel Stouffer's American Soldier (Stouffer et al 1949a; Stouffer et al 1949b). While the subject matter was ostensibly a contribution to military sociology and the morale of soldiers, the lessons gleaned by other researchers – most notably Robert Merton – were relevant to the entire discipline. Merton's elaboration of reference group theory was built on the insights and data presented in Stouffer's American Soldier (Merton & Kitt 1950).

This brings me to the second level of contribution that this dissertation makes. The theory of cultural resonance, the effect of magnets, and the framework of Blau Status Analysis are applicable beyond the substance of political violence. Cultural resonance is relevant to diffusion theory of innovations; magnets are relevant in explaining the search problem faced by populations with rare and stigmatized traits, and Blau Status Analysis is relevant to a large number of questions that interest sociologists. Moreover the dissertation papers resulted in the development of two software programs: the Genkin-Gutfraind Radicalization Ecology ABM and Blaunet[84]. Both pieces of software are freely available to researchers and can be applied to a variety of different topics and issues. I plan to build and develop both the theoretical ideas and the methodological tools and I hope the dissertation and the ideas therein are useful to both students of terrorism and political violence as well as to students of sociology more generally.

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[84] Available for download from www.people.soc.cornell.edu/m

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