Self-Managing Terror: Resolving Agency Problems With Diverse Teams

Peter Schram

June 8, 2019

Abstract

I examine a principal-agents model of subversion with externalities and identify a novel explanation for how diversity can be valuable to organizations: teams of diverse agents can self-manage and mitigate their own agency problems. Generally, this model explores how and when integrating fringe or ideologically extreme agents can align incentives between the principal and all agents. This technique is shown to function better, relative to other contracting techniques, in settings that are bureaucratic and low-information. Self-managing teams are explored in the context Islamist terror groups that use foreign fighters. Because foreign and domestic fighters have conflicting preferences over what types of activities the group should be conducting, if foreign and domestic are integrated onto a team, then the team may self-regulate with efficiency gains for the principal. This model explains variation in agency problems and foreign fighter usage in major insurgent groups, including al Qaeda in Iraq, the Haqqani Network, and the Islamic State.

In the early 1980s, the Haqqani Network faced an existential challenge. The Haqqani Network was one of the major actors in the multi-party insurgency against the Soviet-backed government of Afghanistan. To survive, the Haqqani Network would need to fight both the government and rival local groups through complex and disciplined operations over a vast geographic area, all the while facing intense counterinsurgency pressure. In response to these challenges, the Haqqani Network became a more diverse organization. During this conflict, large numbers of Arab fighters traveled to Afghanistan and fought independently against the Soviet Union as mujahadeen. While these foreign fighters were viewed cautiously by many Afghan insurgent groups due to their extreme ideology, the Haqqani Network was the first group to recognize the foreign fighters' value and to create integrated fighting columns of Afghans and foreign fighters (Hamid and Farrall, 2015, 65-167; Brown and Rassler, 2013, 189-190). And, as an integrated organization, the Haqqani Network has done remarkably well; the Haqqanis have persevered despite nearly four decades of attempts by local actors and global superpowers (the Soviet Union and United States) to destroy the group. In one of the least developed and most conflict prone areas in the world, the Haqqani Network discovered the value of a diverse workforce.

Organizational economics has explanations for how diversity could have been valuable to the Haqqani Network. Following Lazear (1999) or Hong and Page (2001), foreign fighters could have introduced new skills or new perspectives on problem solving to the organization. Alternatively, foreign fighters could have provided more manpower to the groups or were better fighters than domestic agents. Or, in light of "ally principle" type results in the literature on agency problems (Bendor *et al.*, 2001), foreign fighters could have been more allied with Haqqani Network's leadership than domestic agents. If any of these explanations were correct, we would expect similar militant groups to welcome foreign fighters. Instead, there is significant variation in foreign fighter use among prominent violent jihadist groups. In 2007, al Qaeda in Iraq (AQI) began turning foreign fighters away due to internal dysfunction (CTC, 2007a).

In 2015, al Shaabab's leadership tolerated its local fighters killing off its foreign fighter members (Scahill, 2015). And, in 2015, when AQI re-emerged as Daesh (commonly referred to as the Islamic State or ISIS), the group undertook the largest recruitment of foreign fighters in history and took pains to integrate foreign fighters into all levels of the organization (Weiss, 2015; Fishman, 2016). The variation in foreign fighter use merits the following questions: why and when is diversity valuable to militant groups?

Diverse preferences among agents are valuable because they present a solution to a critical organizational design problem: insurgent leadership must design effective teams from imperfect agents to operate in environments where it is difficult for the leadership to discern what actions are appropriate. The Haqqanis discovered that integrated teams of domestic and foreign agents can self-manage their agency problems more effectively than homogeneous teams of domestic agents, surprisingly, even when foreign agents have preferences that are *less* aligned with the preferences of the principal relative to domestic agents. Put another way, in contrast to standard ally principle type results, the Haqqanis discovered that by adding "worse" agents, strategic interactions between different types of imperfect agents can lead to more efficent teams. This paper analyzes this organizational design problem in the context of a principal-agents model of subversion with externalities between agents.

To expand on the organizational design problem, to succeed in an insurgency, an insurgent groups must balance attacking government actors and asserting dominance over local civilian and (at times) rival insurgent groups over a large geographic area. However, what precisely agents should be doing in a given location would be determined by local circumstances. Because observing these local circumstances is risky for the leadership, embedded teams of agents would be cognizant of local circumstances, but insurgent leadership could not discern what agents should be doing without risking capture or death. This opens the possibility for subversion, where agents may conduct the operations that they like rather than what the principal would want them to conduct, without the principal knowing outright that the agents misbehaved. For example, if rival insurgent groups were attacking Haqqani Network agents, the Haqqani Network's leadership would want its agents to respond and engage these rivals; but, if the leadership observes its agents attacking local actors, the leadership would not easily know if the agents were being attacked and responding or if the agents were pursuing local power at the expense of local actor-insurgent relations.

To conduct operations, leadership of jihadist militant groups uses teams of imperfect agents. Domestic fighters are imperfect because their preferences are shaped by their connection to the local population. That local fighters act out and pursue greed, grievance, or personal security is consistent with extensive empirical evidence and historical anecdotes (Weinstein, 2006; Kalyvas, 2006; Enders and Jindapon, 2010; Shapiro, 2013; Schram, 2019).[1] Islamist foreign fighters were also imperfect, but for different reasons. Foreign fighters' traveled and fought because they believed it was their religious duty to protect the Muslim nation (the *umma*) when it faces external threats (Malet, 2010; Hegghammer, 2010). In contrast to local fighters, foreign fighters were enthusiastic to engage government or non-Islamist forces, but foreign fighters were also naive extremists who lacked a stake in the long-run success of the insurgent group, were less willing to attack co-religious rival actors which was necessary to insure the insurgent group emerged dominant (Hafez, 2010; Hegghammer, 2010; McChrystal, 2013; Brown and Rassler, 2013; Schram, 2019) Altogether, at a given point in time, leadership could have preferences that were more aligned with one type of agent over the other, but this would depend on complex local circumstances and this could change over time. Faced with this operating environment, the leadership must effectively design teams, or the leadership risks that agents will misbehave to the detriment of the group.[2]

[1] Trotsky (1971) claimed "local cretinism is history's curse on all peasant riots" and Mao (1938) criticized the peasant guerrilla units "which are frequently preoccupied with local considerations to the neglect of the general interest."

[2] I include a more thorough discussion of actor's preferences below in the "Related Literature" section.

In this setting, two factors drive the result that diverse teams can self-manage their subversion. The first, which was discussed above, is that agents have partially misaligned preferences with the leadership, and that these preferences are misaligned in different ways. The second factor is the externality structure surrounding the agent's actions. When an agent subverts, that agent's like-minded teammates benefit.[3] The agent-agent externality structure used here is different than existing models of shirking (where agents exert less effort or allocate less funds than what the principal would prefer) in terror groups, where agency problems have negative spillovers on proximate agents (Baccara and Bar-Isaac, 2008; Enders and Jindapon, 2010). That an agent's actions have different effects on different types of proximate agents is critical for the results below. For a homogeneous team of agents, agents are collectively incentivised to subvert as each agent benefits from their like-minded teammates' misbehaviors. In contrast, for a heterogeneous team, agents possess internally misaligned preferences over the actions that they want to pursue. Because on a heterogeneous team the agents' preferences for subversion are pulling in different directions, agents may be willing to collectively forgoing misbehaving and instead do what is best for the insurgent group. This dynamic can be illustrated in a simple model of agents interacting within homogeneous and heterogeneous teams.

Consider an infinite-horizon game in which a two-agent team conducts operations. Let $t \in \{1, 2, 3...\}$ denote periods. In each period, nature selects the state of the world $\omega_t \in \{d, f\}$, then each agent observes ω_t and selects action $x_t \in \{d, f\}$. The state of the world identifies the action that the leadership wants the agents to undertake. When $\omega_t = d$ ($\omega_t = f$), the leadership prefers that agents select $x_t = d$ ($x_t = f$). Nature selects $\omega_t = d$ with probability 0.6. Agents have type $\tau \in D, F$, where agents of type $\tau = D$ ($\tau = F$) most prefer action $x_t = d$ ($x_t = f$). Together, nature selecting $\omega_t = d$ with probability 0.6 implies that

[3]Practically, because perusing greed or grievance (for local fighters) or engaging government or Western security forces (for foreign fighters) has spillover effects for proximate agents, agents will benefit when their like-minded teammates subvert.

the leadership's preferences are more aligned with the preferences of type D agents. Agents receive 2 utils when they undertake their most preferred action, 2 utils when their teammate undertakes their most preferred action, and 1 util when they undertake the action that the leadership wants them to undertake.

Below I depict the normal forms of the per-period game for a homogeneous team of agents of type D. Each normal-form game references the per-period game under different states of the world.

Homogeneous Team, $\omega_t = d$

$D \backslash D$	$x_t = d$	$x_t = f$
$x_t = d$	5,5	3,2
$x_t = f$	2,3	0,0

Homogeneous Team, $\omega_t = f$

$D \backslash D$	$x_t = d$	$x_t = f$
$x_t = d$	4,4	2,3
$x_t = f$	3,2	1,1

In both states of the world, it is a Nash equilibrium agents for both type D agents to select the actions that match their type, or setting $x_t = d$, for all $t \in \{0, 1, 2, ...\}$. While sometimes these agents are acting in the interests of the leadership (when $\omega_t = d$), at other times these agents are subverting (when $\omega_t = f$). Similar results holds for two type F agents always setting $x_t = f$.

However, when a diverse team is formed, a new dynamic can arise. Below is the normal form of the per-period game a heterogeneous team.

Heterogeneous Team, $\omega_t = d$

D\F	$x_t = d$	$x_t = f$
$x_t = d$	5,1	3,2
$x_t = f$	2,3	0,4

Heterogeneous Team, $\omega_t = f$

D\F	$x_t = d$	$x_t = f$
$x_t = d$	4,0	2,3
$x_t = f$	3,2	1,5

Under both states of the world, it is a Nash equilibrium for agents to select their most preferred action (type D sets $x_t = 0$ and type F sets $x_t = 1$) for all t. In this equilibrium, agents select the actions they most prefer to the detriment of their partner and the group. For a sufficiently high discount rate ($\delta \geq 0.8\bar{3}$), using Nash a reversion punishment strategy, an alternate, subgame perfect Pareto improving equilibrium exists where agents select the leadership's most preferred actions ($\omega_t = x_t$ for all t). This simple model demonstrates that if agents' preferences for misbehavior are pulling in different directions, they may find it best to coordinate and perform the actions that the leadership would want without the need for oversight by the principal.

This simple model also speaks to when diverse preferences among agents are valuable in the insurgency setting. Comparing the agent's utilities across team structures shows that agents do worse on heterogeneous teams. Unless the leadership can intervene and oversee team formation, agents will form homogeneous teams and will, at times misbehave. Thus, for agents with diverse preferences to be used effectively, the leadership must be able to oversee the team's formation; if the leadership cannot oversee team formation, the leadership may find it best to exclude the agents whose preferences are least aligned. Within insurgent groups, variation in the availability of safe haves approximates the leadership's ability to oversee team. Over the course of the group's history, the Haqqani Network possessed a safe haven either in Eastern Afghanistan or Western Pakistan and organized mixed fighting columns before sending these teams to conduct operations throughout Afghanistan with little direct oversight (Dressler, 2010, Brown and Rassler, 2013, 189-190. In 2006 AQI's operational bases were repeatedly overrun resulting in AQI's leadership decentralizing command authority; as a result, AQI's domestic fighters choose not to work with the foreign fighters, instead leaving foreign fighters behind in safe-houses while local fighters stole from, killed, and generally alienated the Iraqi population, and the leadership eventually began turning foreign fighters away (CTC, 2007a; Fishman, 2009). Several years later, when AQI became the Islamic State of Iraq and the Levant (ISIS) and began holding territory in Iraq and Syria, the group began soliciting foreign fighters and forming integrated operational units (Weiss, 2015; Gates and Podder, 2015).

While the emphasis of this paper is jihadist militant groups, the operating environment described here can apply to other settings where agents have discretion over the types of activities they conduct; it could be argued that teams of aid workers or police forces have preferences over their actions, and this has spillovers on proximate police or aid workers. Additionally, middle-managers in large companies may have preferences over the types or locations of projects that they invest in, and these decisions can have type-dependent externalities for other similarly positioned middle-managers. While this is far from a model for everything, the results here can be generalized for a contribution beyond the literature on agency problems in insurgent groups. I highlight three primary contributions.

First, I present a novel explanation for how diversity can benefit organizations. Lazear (1999) suggested that the existence of the "global firm" is in itself a puzzle, as bringing together a multinational workforce under a single organization imposes a range of linguistic, cultural, and legal costs. While the focus of Lazear was the firm, this same puzzle exists for any organization, local or multinational, that values diversity despite the tensions it may create. This paper suggests that these tensions can be what makes diversity valuable. That teams of diverse agents can self-regulate is fundamentally different from existing explanations for the value of diversity, where production complementaries (Lazear) or new perspectives on problem solving (Hong and Page, 2001) offset the costs from when diverse agents interact. And, while results like this exist in the legislative signaling settings (for examples, see Battaglini (2002) and Hirsch and Shotts (2015)), I show that diversity can also be a simple, "hands-off" tool for addressing moral hazard.

Second, within the context of self-managing teams, I assess the natural intuition that the principal wants agents whose preferences are more aligned with the preferences of the principal. I find this intuition does not hold. Rather, teams self-manage best when agents' preferences "offset" one another, or when agent's ideal points are equidistant from the principal's expected most preferred policy.

In practice, the principal may recruit an agent whose preferences are less like the principal's to better counterbalance the preferences of that agent's teammate.

Third, I show that creating diverse teams functions better, relative to other contracting techniques, in low-information and bureaucratic settings. I consider four techniques for handling principal-agents relations: the principal can construct diverse teams, can use incentive contracts, can construct heterogeneous teams and use incentive contracts, or can let the teams self-form and agents can act unabated. When the costs of per-period oversight or issuing precise transfers is too high (as we would expect in many insurgency settings), the principal may instead construct diverse teams and delegate the management of agency problems to the agents.

I proceed as follows. First I present the general model. Next I describe the dynamics of how heterogeneous teams self-manage. I describe four different ways the principal can align incentives: the principal can use incentive contracts, create a diverse team, both, or neither. I then discuss comparative statics within each case and compare these techniques against one another. I then discuss extensions, empirical motivations for the model, scope conditions, and related literature.

1 Related Literature

The finding presented here, that foreign fighters can help resolve agency problems in insurgent groups, has implications for the organizational economics of militant organizations. Since Crenshaw (1987) and Chai (1993) pioneered an organizational approach to terror groups, a growing literature discusses how terror and insurgent groups mitigate their agency problems (Gates, 2002; Weinstein, 2006; Shapiro and Siegel, 2007; Baccara and Bar-Isaac, 2008; Berman and Laitin, 2008; Enders and Jindapon, 2010; Shapiro, 2013). While I do not want to discount the importance of this literature in explaining many puzzling facets of insurgent organization – see Shapiro (2019) for a review – analyses of agency problems in militant groups rarely consider agent-agent interactions[4] and universally focus on a single type of misbehaving agent; as such, these papers may be missing relevant interactions that exist in large, cooperative, and diverse militant groups, like ISIS or the Haqqani Network. This paper not only finds that integrating foreign fighters can be used to resolve agency problems through agent-agent interactions, which can explain why groups like ISIS and the Haqqani Network value foreign fighters, but also highlights the feasibility of this technique in challenging contracting environments. This paper is similar to Schram (2019), which describes the preferences of actors in an insurgency, introduces the simple model that was presented earlier, and describes how counterinsurgency undermined self-managing teams in AQI. However, this paper differentiates itself from Schram (2019) because the generalized principal-agents model below, discussion on comparative statics and extensions, analysis of the principal's problem, and discussion of non-insurgency applications is all new.

This paper is similar to a series of legislative signaling models that suggest diversity can be exploited for efficiency gains for the principal (Gilligan and Krehbiel, 1989; Dewatripont and Tirole, 1999; Battaglini, 2002; Hirsch and Shotts, 2015). This paper differentiates itself in two ways. First and most clearly, this paper examines subversion in a delegation setting rather than a signaling setting. Second, in the models above, after the principal organizes a diverse team of agents, the principal plays a critical role in realizing the efficiency gains. In Gilligan and Krehbiel (1989); Dewatripont and Tirole (1999); Hirsch and Shotts (2015) the principal is able to assess the quality of a given policy, and in Battaglini (2002) the principal interprets a multidimensional message to construct an optimal policy. Here, in contrast, after the principal organizes a diverse team, the principal can rely on agents to do much of the management.

[4] Baccara and Bar-Isaac (2008) and Enders and Jindapon (2010) are two exceptions.

Additionally, beginning with Holmstrom (1982), a series of papers have also examined principal-agents problems with teams. As examples, these papers address topics ranging from how dividing tasks (Holmstrom and Milgrom, 1991), side contracting (Tirole, 1986; Holmstrom and Milgrom, 1990, 1994; Che and Yoo, 2001; Jackson and Wilkie, 2005), and externalities (Segal, 1999) impact the principal's problem.[5] This paper is more similar to work on the politics of organizational decision making (see Gibbons *et al.* (2013) for a review), where organizational or institutional factors play a significant role in determining how teams behave. For example, Bonatti and Rantakari (2016) describes how strategic interactions among agents with different policy preferences and the costs associated with developing policies can at times lead to greater allocations of effort into producing projects. This paper also speaks to a broad, largely case-based literature on what is needed for self-managing teams to function, which commonly emphases cooperation and communication among teammates and the value of staffing teams with actors possessing minority views (Beyerlein and Johnson, 1994; Yeatts and Hyten, 1998).

1.1 Motivating Actors' Preferences

This discussion provides some brief background on insurgent groups to justify the utility functions in the general model. For a more thorough treatment, see Schram (2019). Within jihadist militant groups participating in multi-party insurgencies, there are three distinct groups of actors that each possess distinct preferences: the leadership, foreign agents, and domestic agents.

To be successful, the leadership must run an organization that balances attacking (at times Western backed) government actors and asserting dominance over civilian and rival insurgent groups (Whiteside, 2016). However, because these preferences would be dictated by local conditions, the leadership would not necessarily know what its agents should be doing. For example, in an extensive

[5] I will not attempt to list all works discussing principal-agent modeling of teamwork. For a more comprehensive review of the modeling of teams and teamwork, refer to Gibbons and Roberts (2012).

internal audit, AQI's internal auditors once observed AQI's agents letting a Coalition force convoy drive by a recently planted explosive device because the agents were waiting to use the explosives against rival local actors (CTC, 2007a). It could have been appropriate for AQI to not use the explosives against Coalition forces (a group they were at war with), but to know this the leadership would have needed a deep understanding of what was occurring on the ground.

Domestic fighters share similar goals as the leadership. However, they tended to care more about gaining a local monopoly on power in the short-term than did the leadership. Domestic fighters possess a pre-existing social network and connection to the local population. Through the common practices of radical Islamist insurgent groups – like enforcing Sharia law and managing smuggling and racketeering (Moghadam and Fishman, 2010; Shapiro, 2013) – domestic members of these groups could settle old grievances, protect themselves and their social network, and pursue wealth to an extent that ideologically driven outsiders (foreign fighters) or the group's leadership both could and would not. This perspective, that local fighters may pursue greed, grievance, or personal security at the expense of the insurgency movement, is consistent with anecdotal evidence within AQI and the Haqqani Network, as well as existing literature on agency problems within domestic insurgencies (Weinstein, 2006; Kalyvas, 2006; Hamid and Farrall, 2015; CTC, 2007a). Additionally, this perspective is not limited to radical Islamist groups. Trotsky (1971) claimed "local cretinism is history's curse on all peasant riots" and Mao (1938) criticized the peasant guerrilla units "which are frequently preoccupied with local considerations to the neglect of the general interest."

Islamist foreign fighters, meanwhile, are ideologues who travel to conflict zones like Iraq in 2003 or Afghanistan in 2001 because they believe it is their religious duty to protect the Muslim nation (the *umma*) when it faces external threats such as the one posed by western forces or western backed governments (Malet, 2010; Hegghammer, 2010). For that reason, foreign fighters prefer to engage

Western security forces or non-radical Islamist governments (like the Afghan government under Hamid Karzai or the Iraqi government under Nouri al-Maliki) than engage co-religious militants or civilians (Hafez, 2010). Secondary documents on foreign fighter ideology and recruitment patterns (Felter and Fishman, 2007; Hafez, 2010; Kirdar, 2011), messages to would-be and existing foreign fighters (al Zarqawi, 2004), and internal documents discussing the motivations and religious devotion of foreign fighters (CTC, 2007a) all support this view. Of course, this is not to say that no foreign fighters were willing to declare other Islamists as apostates and to attack or kill these individuals. Rather, foreign fighters preferred to engage Western forces or non-Islamist backed government forces more than they wished to engage coreligionists and to become involved in local political disputes.

Thus, leadership possessed preferences that were sometimes more in line with the preferences of foreign fighters, sometimes more in line with those of local fighters, and would depend on what was occurring locally. Overall, however, I also assume leadership preferences were closer to those of domestic fighters because both groups shared a desire to consolidate their power in the country after competing parties were defeated. In contrast, foreign fighters are generally viewed as less interested in securing a group's long run success and more interested in engaging Western or apostate government forces (Hegghammer, 2010). Should the militant group be successful, foreign fighters would move on to the next battle zone. Furthermore, foreign fighters, relative to domestic fighters, are younger and less experienced, are commonly viewed as more ideologically rigid, and are more interested in supporting the insurgent movement rather than the local politicking necessary to win an insurgency. This assumption has empirical significance: because foreign fighters are less aligned with the preferences of the leadership, if forced to choose, leadership will work with local fighters rather than foreign fighters (as happened in AQI and al Shabaab).

2 Model

This is a principal-agents model of subversion with externalities between agents. The model has two stages: a first stage where the principal designs the organization, and a second stage where agents repeatedly conduct operations.

In the first stage the principal can define utility transfers to agents and can oversee the formation of a terror cell. Regarding utility transfers, the principal can transfer utility to the agents based on the agents' actions (an incentive contract) or at a flat rate. In order to condition transfers on the agent's actions, the principal must set $m = 1$ and incur "monitoring" cost $\zeta > 0$. If the principal sets $m = 0$, the principal does not incur a cost, but can still offer agents a flat utility transfer. Incentive contracts will be described in more detail below. Regarding cell formation, agent 1 is assumed to be a domestic type,[6] and the principal sets $o_p \in \{d, f, u\}$ to designate agent 2 as a domestic ($o_p = d$) or foreign type ($o_p = f$), or to remain uncommitted and delegate this decision to agent 1 ($o_p = u$). If the principal sets $o_p = f$ or $o_p = d$, the principal pays a one-time "organization" costs κ. If the principal sets $o_p = u$ and remains uncommitted, then agent 1 selects $o_1 \in \{d, f\}$ to partner with either a domestic type or foreign type agent 2. When transfers and team composition are set, agents have the option to not participate in operations. Agents can accept or reject being in the group through setting $b_i = a$ or $b_i = r$ (respectively). If either agent selects r, then the game terminates and all actors receive their reservation utilities denoted by R_p and R_a for the principal and agents (respectively).

The second stage is an infinite horizon game where agents repeatedly conduct operations. Time is discrete and indexed by $t \in \{1, 2, 3, ...\}$. At the start

[6] This is a simplifying assumption, as the principal weakly prefers that agent 1 is the type of agent whose preferences are more in line with the leadership. I discuss this more in the expanded section on agent's preferences, but because foreign fighters lack a long-run stake in the insurgent group, I assume domestic fighters have prefrences that are more aligned with leadership

of each period t, nature draws a realization of $\omega_t \in [-1, 1]$ which represents what actions the principal wants the agents to perform. Each ω_t is drawn independently from a continuous distribution function F with full support where $\mathbb{E}(\omega_t) = 0$. The distribution F is common knowledge and the agents observe ω_t, but the principal does not. After ω_t is realized, both agents simultaneously select actions $a_{i,t} \in \mathbb{R}$ with $i \in \{1, 2\}$. The convexity of the action space captures that in a given period, agents allocate their time to some mixture of activities and that the principal has some most preferred mix of activities (represented by ω_t). In the insurgency setting, agents can spend more time attacking local actors or rival insurgent groups (represented by more negative values of $a_{i,t}$), spend more time attacking government actors or Western forces supporting government actors (represented by more positive values of $a_{i,t}$), or spend time mixing between the two (values of $a_{i,t,}$ close to 0). After agents conduct actions, per-period utilities are realized, the game moves to period $t = t + 1$.

Different types of agents have different ideal points over their teammates and their own actions. I assume domestic type actors generally prefer taking actions against local actors or rival insurgent groups, and foreign actors generally prefer taking actions against Western or government forces; I justify these preferences in the "Additional Questions" section. Formally, domestic types have ideal point χ_d where $\chi_d \leq -1$, and foreign types have ideal point χ_f where $\chi_f \geq 1$. Also, I assume in expectation the leadership's preferences are weakly more in line with domestic agents, or $|\chi_d| \leq |\chi_f|$.

For agent $i \in \{1, 2\}$ that is type $\tau \in \{d, f\}$, and letting $j \in \{1, 2\}$ with $i \neq j$, summed across periods, agent i has utility function

$$U_i = \sum_{t=1}^{\infty} \delta^{t-1} \left(-\alpha|a_{i,t} - \chi_\tau| - \beta|a_{j,t} - \chi_\tau| - \gamma|a_{i,t} - \omega_t| + G_{i,t}\right). \tag{1}$$

I let $\delta \in (0, 1)$ denote the common discount factor and $\alpha > 0$, $\beta > 0$, and $\gamma > 0$ denote constants. I assume agents incur disutility when they and their partners select actions that deviate from their ideal points, as represented in the linear[7] loss terms $-\alpha|a_{i,t} - \chi_\tau|$ and $-\beta|a_{j,t} - \chi_\tau|$. Practically, these terms imply that domestic agents incur disutility when they and their teammates are not pursuing local power, and foreign agents incur disutility when they and their teammates are not engaging Western forces. Agents would be expected to value their own actions over the actions of their teammates, so I let $\alpha > \beta$. Also, I assume that when agents deviate from what the principal would want them to do, they incur disutility, as represented in the $-\gamma|a_{i,t} - \omega_t|$ term. Practically, when agents subvert, they are inappropriately attacking actors, fostering new hostilities, or generally undertaking actions that have negative ramifications for the group, which would have a negative impact on the misbehaving agents.[8] I assume $\alpha > \gamma$, which implies agents are motivated to subvert. The $G_{i,t}$ function denotes the per-period utility transfer from the principal to agent i. I limit the analysis to contracting schedules that, for a transfer in period t, do not rely on events or information outside of what occurred in period t. The transfer function can then be defined as mapping $G_{i,t} : \{\emptyset\} \cup \mathbb{R} \times \mathbb{R} \to \mathbb{R}_+$.

The principal has utility function

$$U_p = \sum_{t=1}^{\infty} \delta^{t-1} \left(-|a_{1,t} - \omega_t| - |a_{2,t} - \omega_t| - G_{1,t} - G_{2,t} - m\zeta\right) - 1_{o\in\{d,f\}}\kappa. \quad (2)$$

The principal most prefers both agents set their actions $a_{i,t} = a_{j,t} = \omega_t$. Additionally, the principal may choose to pay incentive contracting and oversight costs, as represented in the $G_{1,t}$, $G_{2,t}$, $m\zeta$, and $1_{o\in\{d,f\}}\kappa$ terms.

For ease, assumption 0 summarizes the above assumptions on preferences.

[7] I assume linear utility functions to allow the principal to achieve the first-best outcome when using incentive contracts. Linear utilities here "stack the deck" in favor of using incentive contracts, which makes them a more competitive benchmark to creating self-managing teams.

[8] It might also be expected that one agent's subverting would hurt that agent's teammate. Making this assumption would strengthen the success of heterogeneous teams resolving agency problems.

Assumption 0: $\alpha > 0$, $\beta > 0$, $\gamma > 0$, $\alpha > \beta$ and $\alpha > \gamma$. Realizations of the principal's preferred activities are represented by $\omega_t \in [-1, 1]$, where $\mathbb{E}(\omega_t) = 0$. The agent's ideal points correspond to these points by $\chi_d \leq -1 < \mathbb{E}(\omega_t) < 1 \leq \chi_f$, with $|\chi_d| \leq |\chi_f|$.

Also for ease, the game form is as follows.

1. The principal selects monitoring decision $m \in 0, 1$, organization decision $o_p \in \{d, f, u\}$, and transfers $G_{1,t} : \{\emptyset\} \cup \mathbb{R} \times \mathbb{R} \to \mathbb{R}_{\geq}$ and $G_{2,t} : \{\emptyset\} \cup \mathbb{R} \times \mathbb{R} \to \mathbb{R}_{\geq}$ for all t.
2. If the principal set $o_P \in \{d, f\}$, the game proceeds to step 3. If the principal set $o_P = u$, agent 1 selects if agent 2 is domestic $o_a = d$ or foreign $o_a = f$.
3. Having observed the contracts, each agent accepts being in the group and sets $b_i = a$ or rejects the group and set $b_i = r$. If either agent rejects the group, then the game terminates and all actors receive their reservation values (R_p and R_a).
4. Period $t = 1$ begins.
5. Nature designates $\omega_t \in [-1, 1]$, which is observed by the agents.
6. Agents 1 and 2 simultaneously select actions $a_{1,t} \in \mathbb{R}$ and $a_{2,t} \in \mathbb{R}$ (respectively).
7. Utilities are realized and the game repeats starting at step 5, updating the period to $t = t + 1$.

I limit my analysis to subgame perfect equilibria. Even so, multiple equilibria can exist in the repeated second stage. To further limit the set of subgame perfect equilibria, I introduce three criteria for equilibrium selection. First, I will only consider equilibria supported by Nash reversion. Second, I will only consider a type of subgame perfect equilibrium that I refer to as a "shading equilibrium."

Definition: A subgame perfect equilibrium is a "**shading equilibrium**" if, letting $z_i \in [0, 1]$, agent i that is type τ selects actions $a_{i,t} = z_i\omega_t + (1 - z_i)\chi_\tau$ for all t.

Each agent's per-period actions follow from the above affine function of the state variable and the choice variable z_i, and are restricted to fall between the agent's ideal point and the state variable. Put less formally, in a shading equilibrium, agents "shade" some fixed proportion z_i towards the principal's ideal point at ω_t from their ideal point at χ_d or χ_f. Subgame perfect equilibria that are not shading equilibria include equilibria when agents vary their behavior across periods[9] or select from different functional forms based on the state variable.[10] The assumption that agents only select values between their ideal points (χ_d and ω_t or χ_f and ω_t) is in place to simplify analysis – I relax this in the "Additional Questions" section, and the results do not substantively change.

As the third criterion, I assume that agents select the shading equilibria where agents "shade" the most towards the principal's most preferred actions ω_t. Regardless of whether a domestic-domestic or domestic-foreign team is formed, when the principal is not using utility transfers, both agents setting $z_1 = z_2 = 0$ always constitutes a shading equilibrium. However, this may not be the only shading equilibrium. The third criterion resolves this, and all three criterion are summarized in Assumption 1.

Assumption 1: Agents will select the shading equilibrium that is supported by Nash reversion and that is characterized by (z_1, z_2) where
$(z_1, z_2) \in \underset{(z_1,z_2)\in Z^*}{\arg\max} \{-|a_{1,t}(z_1, \omega_t) - \omega_t| - |a_{2,t}(z_2, \omega_t) - \omega_t|\}$.

[9] For example, agents select $z_i = 0.6$ on even periods and $z_i = 0.4$ on odd periods.

[10] For example, when $\omega_t \leq 0$ domestic agents select $a_{i,t} = \omega_t - 0.5(\omega_t - \chi_d)$ and when $\omega_t > 0$ domestic agents select $a_{i,t} = 0.1 + \omega_t - 0.5(\omega_t - \chi_d)$.

Being cognizant of Folk Theorem type results in repeated games, readers may be worried that Assumption 1 induces agents select an odd equilibrium where the equilibrium's peculiarities are necessary for heterogeneous self-managing teams to function. Discussing each criterion, limiting analysis to shading equilibria imposes a simple structure to equilibria analysis. Limiting analysis to equilibria supported by Nash reversion eliminates potentially implausible equilibria that rely on extreme off-path punishments – also, this criterion means that any selected equilibrium will be weakly better for the agents than the $z_1 = z_2 = 0$ shading equilibrium (where agents match their actions to their ideal points). And, while limiting analysis to equilibria where agents select the actions that are closest to the principal's ideal point may seem strong, this is like assuming that the principal can "nudge" agents deciding between multiple equilibria into the one that is good for the organization (and that is Pareto improving for the agents from the $z_1 = z_2 = 0$ shading equilibrium); practically, by virtue of being the leader of a large, successful militant group, leadership probably has some managerial ability to convince agents not to play destructive equiliria. Also, in the Additional Questions Section, I relax Assumption 1 by considering both non-shading equilibria and the case when agents select actions that maximizes the team's joint utility;[11] these changes do not substantively change the results.

3 How Diverse Teams of Agents Behave

Before discussing the techniques the principal can use, I first describe the mechanics of how a diverse team will self-manage manage in the repeated second stage. On a diverse team, a shading equilibrium always exists where agents match their actions to their respective ideal points $a_{1,t} = \chi_d$ and $a_{2,t} = \chi_f$ for all t ($z_1 = z_2 = 0$). While the $z_1 = z_2 = 0$ equilibrium may not satisfy the maximization condition within Assumption 1, this equilibrium can act as the Nash reversion punishment-phase that players would enter upon

[11] There is no way to identify the single "best" equilibrium for the agents because, on a heterogeneous team, there can exist multiple Pareto efficent equilibria.

observing deviations from equilibrium behavior. Following Assumption 1, within a heterogeneous team, agents select actions $a_{1,t} = (1 - \tilde{z}_1)\chi_d + \tilde{z}_1\omega_t$ and $a_{2,t} = \tilde{z}_2\omega_t + (1 - \tilde{z}_2)\chi_f$ for all t, with $\tilde{z}_1$ and $\tilde{z}_2$ defined below.

Definition: $\tilde{z}_1$ and $\tilde{z}_2$ are defined as as

- $\tilde{z}_1 = 1$ and $\tilde{z}_2 = 1$ if $\tilde{k}_f \geq 1$,
- $\tilde{z}_1 = 1$ and $\tilde{z}_2 = \tilde{k}_f$ if $\tilde{k}_d\tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$, and
- $\tilde{z}_1 = 0$ and $\tilde{z}_2 = 0$ if $\tilde{k}_d\tilde{k}_f < 1$,

where $\tilde{k}_d = \frac{\delta\beta\chi_f}{(\alpha-\gamma)(1-\delta-\chi_d)}$ and $\tilde{k}_f = \frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)}$.

I derive $\tilde{z}_1$ and $\tilde{z}_2$ in the Appendix. To provide some intuition for these values, I plot $\tilde{z}_1$ and $\tilde{z}_2$ relative to χ_d below. Note that the expressions $\tilde{k}_f$ and $\tilde{k}_d\tilde{k}_f$ are both decreasing in χ_d.

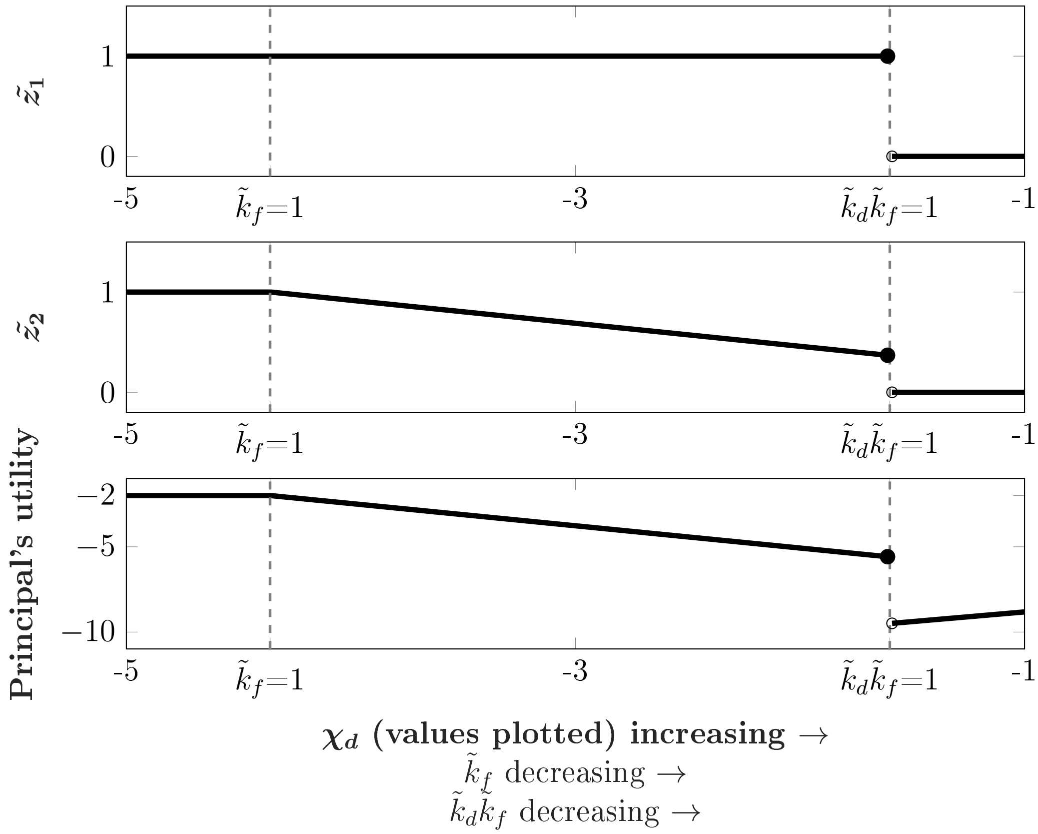

Figure 1: Plots of $\tilde{z}_1$, $\tilde{z}_2$, and the Principal's utility against values of χ_d.

Notes: Parameter values are $\alpha = 2.4$, $\beta = 2.25$, $\gamma = 2.2$, $\delta = 0.12$, $\chi_f = 5$, and $\chi_d \in [-5, -1]$. The "Principal's Utility" refers to the principal's expected utility from the agent's actions. The expressions $\tilde{k}_f$ and $\tilde{k}_d\tilde{k}_f$ are both decreasing in χ_d, which implies that: (a) in the region left of the $\tilde{k}_f = 1$ border, $\tilde{k}_d > 1$ and $\tilde{k}_f > 1$ holds; (b) in the region right of the $\tilde{k}_d\tilde{k}_f \geq 1$ border, $\tilde{k}_d\tilde{k}_f < 1$ holds; and (c) in the region in between, $\tilde{k}_f \leq 1$ and $\tilde{k}_d\tilde{k}_f \geq 1$ holds.

As I show in the Appendix, agents are willing to shade up to levels $z_1 \leq min\left\{1, z_2\tilde{k}_d\right\}$ and $z_2 \leq min\left\{1, z_1\tilde{k}_f\right\}$. Due to the maximization condition within Assumption 1, these inequalities will hold with equality. The feature that each agent's willingness to shade is an increasing function of their teammates shading level creates the three parts to the shading levels; to illustrate why, it is useful to compare the case when $\tilde{k}_d < 1$ and $\tilde{k}_f < 1$ to the case when $\tilde{k}_f \geq 1$

(which, by Assumption 0, implies that $\tilde{k}_d \geq 0$). When $\tilde{k}_f \geq 1$ (the portion of Figure 1 to the left of $\tilde{k}_f = 1$), each agent is willing to shade at a level weakly greater than that of their teammates, resulting in $\tilde{z}_1 = \tilde{z}_2 = 1$ as the selected equilibrium shading levels. In contrast, when $\tilde{k}_d < 1$ and $\tilde{k}_f < 1$ (which occurs for the smallest values of χ_d within portion of Figure 1 to the right of $\tilde{k}_d\tilde{k}_f = 1$), each agent is only willing to shade a fraction of their teammate's selected level of shading, making $\tilde{z}_1 = \tilde{z}_2 = 0$ the only possible shading equilibrium. The equilibrium behavior between these parameter spaces is dictated by whether $\tilde{k}_d\tilde{k}_f \geq 1$ or $\tilde{k}_d\tilde{k}_f < 1$, which is the cut point where non-zero shading levels can (or cannot) be supported. Thus, referencing the bullet points: when $\tilde{k}_f \geq 1$, agents set $\tilde{z}_1 = 1$ and $\tilde{z}_2 = 1$, meaning they are completely self-managing their agency problems; when $\tilde{k}_d\tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$, agents set $\tilde{z}_1 = 1$ and $\tilde{z}_2 = \tilde{k}_f$, meaning agent 1 matches their action to the principal's most preferred action, but agent 2 only partially self-manages;[12] when $\tilde{k}_d\tilde{k}_f < 1$ then no non-zero level of shading can be supported.

Based on $\tilde{z}_1$, and $\tilde{z}_2$, I can discuss comparative statics on the principal's expected utility from the agent's actions in Observation 1. The most important comparative statics to consider are those when agents are actually self-managing, which occurs when $\tilde{k}_d\tilde{k}_f \geq 1$, or when changes in parameters induces agents to shift from not self-managing to self-managing, which occurs when $\tilde{k}_d\tilde{k}_f < 1$ shifts to $\tilde{k}_d\tilde{k}_f \geq 1$.

Observation 1: Within a heterogeneous team:

- within the region where $\tilde{k}_d\tilde{k}_f \geq 1$, the principal's expected utility is weakly decreasing in α, weakly increasing in β and γ, and weakly decreasing in χ_d and χ_f.
- the expression $\tilde{k}_d\tilde{k}_f$ is decreasing in α, increasing in β and γ, and decreasing in χ_d. If a change in α, β, γ, or χ_d induces a change from $\tilde{k}_d\tilde{k}_f < 1$ to

[12] Because $|\chi_d| \leq |\chi_f|$, agent 1 is always willing to select a level of shading $\tilde{z}_1$ that is (weakly) greater than $\tilde{z}_2$.

$\tilde{k}_d\tilde{k}_f \geq 1$ (or from $\tilde{k}_d\tilde{k}_f \geq 1$ to $\tilde{k}_d\tilde{k}_f < 1$), then the principal's expected utility is strictly increasing (or strictly decreasing) in that variable.

- the expression $\tilde{k}_d\tilde{k}_f$ is increasing in χ_f. If a change in χ_f induces a change from $\tilde{k}_d\tilde{k}_f < 1$ to $\tilde{k}_d\tilde{k}_f \geq 1$ or from $\tilde{k}_d\tilde{k}_f \geq 1$ to $\tilde{k}_d\tilde{k}_f < 1$, the effects on the principal's utility are ambiguous.
- within the region where $\tilde{k}_d\tilde{k}_f < 1$, the principal's expected utility is unchanging in α, β, and γ, strictly increasing in χ_d, and strictly decreasing in χ_f.

The most surprising result is that, when $\tilde{k}_d\tilde{k}_f \geq 1$, the principal's expected utility is weakly decreasing in χ_d. As shown in Figure 1, when χ_d decreases – when the domestic agent's ideal point is further from the set of actions that the principal wants the agent to conduct – the team will weakly shade more towards the principal's ideal actions, with weak utility gains for the principal. This result contrasts standard ally principle type results and shows that the closer agent 1's ideal point is to the action the principal wants the agents to conduct, the weakly worse the principal does.

The intuition for why decreasing χ_d can be better for the principal is as follows. Consider what a decrease in χ_d does when $\tilde{k}_d\tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$. By decreasing χ_d, it makes the Nash reversion punishment of $\tilde{z}_1 = \tilde{z}_2 = 0$ worse for the foreign agent (agent 2) because χ_d becomes further from χ_f. By making deviations from equilibrium behavior worse, agent 2 is willing to remain in a broader set of non-zero shading equilibria, which is reflected in the increase in $\tilde{k}_f$. Due to the maximization condition in Assumption 1, the increase in $\tilde{k}_f$ is reflected in equilibrium behavior where $\tilde{z}_2 = min\left\{\tilde{k}_f, 1\right\}$. Of course, decreasing χ_d also affects agent 1. As a first order effect, decreasing χ_d makes agent 1 setting $\tilde{z}_1 = 1$ worse for agent 1. However, as a second order effect, decreasing χ_d increases $\tilde{z}_2$, which makes remaining on the equilibrium path better for agent 1. In aggregate, decreases in χ_d help support non-zero shading equilibria; taking first order conditions of the $\tilde{k}_d\tilde{k}_f$ expression shows that decreases in χ_d increases $\tilde{k}_d\tilde{k}_f$, meaning that a decrease in χ_d will never break the $\tilde{k}_d\tilde{k}_f \geq 1$ condition, implying that agent 1 is willing to remain at $\tilde{z}_1 = 1$. Altogether, when $\tilde{k}_d\tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$, decreasing χ_d results in agent 1 remaining at $\tilde{z}_1 = 1$ and agent 2 selecting a greater level of shading, which is good for the principal. For similar reasons as outlined above, when $\tilde{k}_d\tilde{k}_f < 1$, a decrease in χ_d may flip the $\tilde{k}_d\tilde{k}_f < 1$ inequality to $\tilde{k}_d\tilde{k}_f \geq 1$, resulting in agents changing from setting $\tilde{z}_1 = \tilde{z}_2 = 0$ to $\tilde{z}_1 = 1$ and $\tilde{z}_2 > 0$, which is good for the principal.

In contrast to the results on χ_d, the closer agent 2's ideal point is to the set of actions that the principal wants the agent to conduct (smaller χ_f), the better the principal does. Taken together, the comparative statics on χ_d and χ_f results suggest that, conditional on $\tilde{k}_d\tilde{k}_f \geq 1$, heterogeneous teams are most effective for the principal the closer $|\chi_d|$ and $|\chi_f|$ are to one another; essentially, it is best when agent's ideal points are closer to symmetric.

There is empirical evidence of insurgent leadership seeking agents with symmetric and offsetting preferences. In ISIS, insurgent leadership likely had little control over the preferences of foreign fighters who traveled to fight for their cause; for heterogeneous teams to work most effectively, conditional on the extreme preferences of foreign fighters, the theory predicts that ISIS' leadership should recruit domestic agents that are fairly extreme, though in different ways from the foreign agents. ISIS accomplished this by recruiting former members of the Arab Socialist Ba'ath Party, whose members historically possessed a strong political ideology rather than religious identity (Fishman, 2016). Of course, ISIS is not the only group that started as a combination of individuals possessing distinct identities. The Red Commandos, a violent criminal organization that operates in Brazilan favelas, originated when leftist guerillas joined forces with robbers and murders during their shared time occupying high-security prisons in the 1970s-1980s (Grillo, 2016, 29-43).

Additionally, Observation 1 reveals that the more agents know of and care about the actions of their teammates (greater β), the Nash reversion punishment phase (agents setting $a_{1,t} = \chi_d$ and $a_{2,t} = \chi_f$ for all t following the defection) becomes worse, which in turn can support a greater range of productive (for the principal) shading equilibria. Consistent with theoretical expectations, militant groups do seem care about raising agents' intraorganizational awareness, which is one interpretation of β. For example, the Daesh newsletter and twitter account typically distributed information about group member's activities, ranging from providing public goods to committing beheadings. While communications that raise intra-organizational awareness may be beneficial outside of self-managing teams – for example, internal newsletters could breed useful competition among agents – this model provides a new explanation for why raising the salience of others' activities within an organization can lead to greater productivity.

I include a discussion of other comparative statics in the Online Appendix.

4 How the Principal Behaves

As a final simplifying assumption, I assume that all agents want to be in the militant group. Verbally, I am assuming that the worst equilibrium outcome for the agents in the second stage is still better than their reservation utility. I will relax Assumption 2 in the "Additional Questions" section.

Assumption 2: $-\left[(\chi_f - \chi_d)(\beta) + \gamma\chi_f\right]/(1-\delta) \geq R_a$.[13]

4.1 Summary of Techniques for Handling Subversion

I will consider four techniques. The principal can let the team operate independently (Hands-Off), can form a heterogeneous team (Heterogeneous Teams), can offer the smallest amount needed to completely align incentives (Incentive Contracts), or can make a heterogeneous team and offer an optimal incentive contract (Heterogeneous Teams with Incentive Contracts).

[13] The left hand side is the expected value a foreign agent would receive from being on a team with a domestic agent where both agents always matched their action to their ideal point.

Definition: In the **Hands-Off Technique**, the principal does not issue transfers ($G_1 = G_2 = 0$), monitor the agents' per-period actions ($m = 0$), or designate team composition ($o_P = u$).

Definition: In the **Heterogeneous Teams Technique**, the principal forms a heterogeneous team ($o_p = f$), but does not issue transfers ($G_1 = G_2 = 0$) or monitor the agents per-period actions ($m = 0$).

Definition: In the **Incentive Contracts Technique**, the principal monitors the agents' per-period actions $m = 1$ and offers each agent transfers of $(\alpha - \gamma)(a_{i,t} - \chi_d)$, but does not designate team composition ($o_P = u$).

Definition: In the **Heterogeneous Teams with Incentive Contracts Technique**, the Principal sets $m = 1$, $o_p = f$, and offers transfers, $G_{1,t}(a_1) = \hat{g}_1^*(a_{1,t,} - \chi_d)$ and $G_{2,t}(a_2) = \hat{g}_2^*(\chi_f - a_{2,t,})$ where $\hat{g}_1^*$ and $\hat{g}_2^*$ maximize the principal's expected utility.

Within each technique, I describe how the agents play the game, the actor's utilities, and comparative statics. I then discuss the principal's optimal choice across techniques.

To preface what is to come, I include Figure 2 which illustrates how varying monitoring costs ζ and organizational costs κ influence which technique the principal selects, as well as the organizations that use the various techniques.

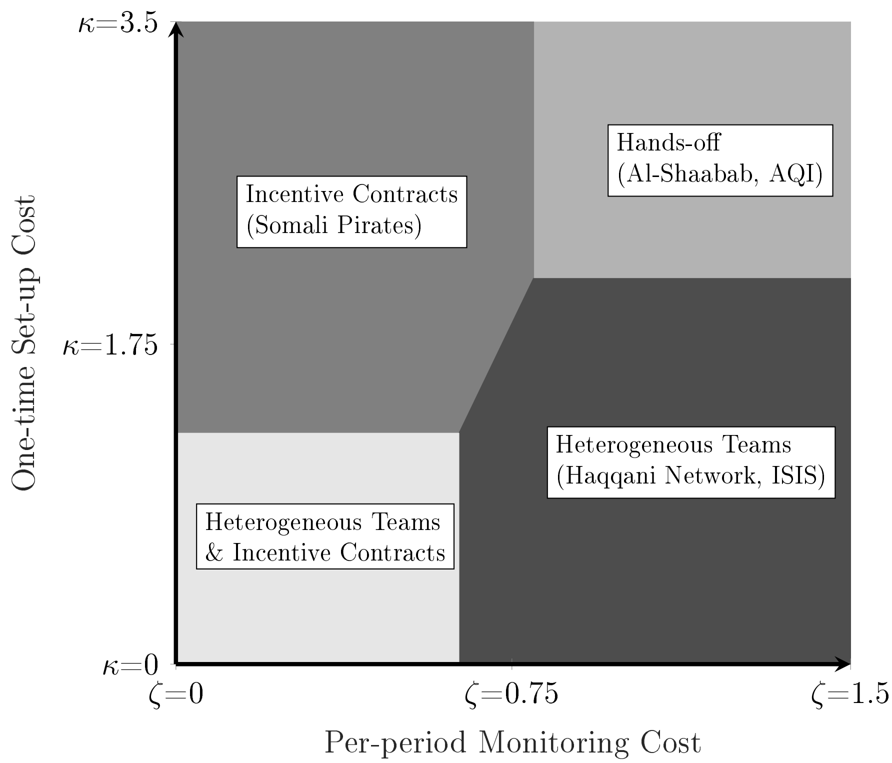

Figure 2: Optimal Team Management Techniques

Notes: κ and ζ varies along the y-axis and x-axis (respectively). Parameter values are $\alpha = 1$, $\beta = 0.9$, $\gamma = 0.4$, $\delta = 0.8$, $\chi_d = -1$, and $\chi_f = 2.7$. For these parameters, optimal contracting with the Heterogeneous Teams with Incentive Contracts Technique was identified computationally using the Nealder-Mead simplex algorithm.

4.2 Heterogeneous Teams Technique

When the principal forms a heterogeneous team, agents will sometimes self-manage with efficiency gains for the principal. How the agents behave was characterized in the definitions of $\tilde{z}_1$ and $\tilde{z}_2$, and comparative statics were explored in Observation 1. I summarize the actions and expected utilities in Proposition 1.

Proposition 1: Within the Heterogeneous Teams Technique:

- Agents set $a_{1,t} = (1 - \tilde{z}_1)\chi_d + \tilde{z}_1\omega_t$ and $a_{2,t} = \tilde{z}_2\omega_t + (1 - \tilde{z}_2)\chi_f$ for all $t \in \{1, 2, 3, ...\}$,
- $\mathbb{E}U_p = ((1 - \tilde{z}_1)\chi_d - (1 - \tilde{z}_2)\chi_f) / (1 - \delta) - \kappa$,
- $\mathbb{E}U_1 = (\alpha\tilde{z}_1\chi_d - \beta ((1 - \tilde{z}_2)\chi_f - \chi_d) - \gamma(1 - \tilde{z}_1)(-\chi_d)) / (1 - \delta)$,
- $\mathbb{E}U_2 = (-\alpha\tilde{z}_2\chi_f - \beta (\chi_f - (1 - \tilde{z}_1)\chi_d) - \gamma(1 - \tilde{z}_2)(\chi_f)) / (1 - \delta)$.

Proof: See Appendix.

4.3 Hands-Off Technique

When the principal lets the team operate independently, agent 1 will form a homogeneous team, and agents will subvert.

Proposition 2: Within the Hands-Off Technique:

- Agents set $o_a = d$, $a_{1,t} = \chi_d$, and $a_{2,t} = \chi_d$ ($z_1 = 0$ and $z_2 = 0$) for all $t \in \{1, 2, 3, ...\}$.
- $\mathbb{E}U_p = 2\chi_d/(1 - \delta)$,
- $\mathbb{E}U_1 = \gamma\chi_d/(1 - \delta)$,
- $\mathbb{E}U_2 = \gamma\chi_d/(1 - \delta)$.

Proof: See Appendix.

Observation 2 describes comparative statics.

Observation 2: Within the Hands-Off Technique, the principal's expected utility does not change with α, β, or γ. The principal's expected utility is increasing in χ_d and is unchanging in χ_f.

The Hands-Off Technique results in some standard ally-principle type results. Within this technique, so long that $\alpha > \gamma$ (as assumed by Assumption 0), agents want to subvert. Thus, the closer χ_d is to the principal's expected most-preferred action ($\mathbb{E}(\omega_t) = 0$), the better the principal will do.

4.4 Incentive Contracts Technique

When the principal offers agents $G_{i,t} = (\alpha - \gamma)(a_{i,t} - \chi_d)$, agent 1 will partner with a domestic agent, and agents will not subvert.

Proposition 3: Within the Incentive Contracts Technique:

- Agents set $o_a = d$, $a_{1,t} = \omega_t$, and $a_{2,t} = \omega_t$ ($z_1 = 1$ and $z_2 = 1$)for all $t \in \{1, 2, 3, ...\}$.
- $\mathbb{E}U_p = (2\chi_d(\alpha - \gamma) - \zeta) / (1 - \delta)$,
- $\mathbb{E}U_1 = (\beta + \gamma)\chi_d/(1 - \delta)$,
- $\mathbb{E}U_2 = (\beta + \gamma)\chi_d/(1 - \delta)$.

Proof: See Appendix.

Under the transfers defined above, two domestic type agents are indifferent over shading levels $z_i \in [0, 1]$. Here agent 1 does best selecting a domestic type partner, and the principal achieves the first-best contracting outcome where agents do not subvert.

Observation 3: Within the Incentive Contracting Technique, the principal's expected utility is strictly decreasing in α, unchanging in β, and strictly increasing in γ. The principal's expected utility is strictly increasing in χ_d and is unchanging in χ_f.

The Incentive Contracts Technique also results in ally principle type results. As χ_d increases, α decreases and γ increases, the agents' preferences are closer to those of the principal, making it less costly to buy good behavior through utility transfers.

4.5 Heterogeneous Teams with Incentive Contracts Technique

When the principal forms a heterogeneous team, oversees the agents' actions, and offers agents some optimal incentive contract, agents may shade towards the state of the world. I limit analysis to incentive contracts that adopt the common form of rewarding agents for deviating from their ideal points. Formally, the principal will select some optimal "transfer constants" g_1^* and g_2^* which define transfers $G_{1,t}(a_1) = g_1^* \left(a_{1,t,} - \chi_d\right)$ and $G_{2,t}(a_2) = g_2^* \left(\chi_f - a_{2,t,}\right)$.

I discuss the mathematical details for this technique in the Appendix. This includes Proposition 4 and Observation 4. The key results are that the principal's expected utility is weakly increasing in $-\alpha$, β, and γ. However, this technique requires much of the principal: in addition to being able to oversee the organization and monitor the agents' actions, the principal must able to design transfers that optimize a fairly complex discontinuous function. Likely in part due to these reasons, to the best of my knowledge, no militant group actually uses this technique, but in theory a group could achieve more efficient outcomes by creating a heterogeneous team and offering contracts.

4.6 Management Costs and Principal's Problem

Management costs influence the principal's technique selection in observable ways. In any setting, getting to know the agent's types, monitoring the agents' actions, and shaping organizational facets to better motivate agents requires time and effort on the part of the principal. In the insurgency setting, this becomes an even greater challenge because any time the principal interacts with agents, the principal is at risk of exposing the agents, of being captured or killed, or of compromising future operations. This model captures two types of management costs: κ denotes the one-time cost for overseeing the organization of the cell, and ζ denotes per-period costs for monitoring the actions of the agents. To empirically ground the distinction, an insurgent group with a safe haven would have a smaller κ, because the principal could organize the cell then send it into the conflict theater, but a safe haven would make little difference for the costs ζ of monitoring the actions of agents.[14]

Low organizational costs κ combined with low per-period monitoring costs ζ could make Heterogeneous Teams with Incentive Contracts most appealing. If organizational costs increase but per-period monitoring costs do not increase, the principal may select Incentive Contracts and let agents self-organize. Alternatively, if per-period monitoring costs were low but organizational costs were high, then the principal may select into Heterogeneous Teams. If all oversight costs are high, then the principal may select the Hands-Off technique. This intuition is depicted in Figure 2.

There is evidence that the Haqqani Network (from the 1980s to the present) and ISIS (circa 2016) used a version of self-managing teams. Both groups benefited from the existence of a safe haven in Pakistan or in Syria that reduced organizational oversight costs κ. And, both groups took pains to integrate foreign fighters into operations, whether it was the Haqqani Network embedding small teams of foreign fighters alongside their regular forces or creating integrated ranks (Hamid and Farrall, 2015, 65-167; Brown and Rassler, 2013, 189-190) or it was ISIS making sure teams consisted of agents from multiple backgrounds (Weiss, 2015; Zelin, 2018). This is not to say that foreign and domestic foreign agents got along; consistent with the discussion on preferences and theoretical expectations,[15] foreign and domestic fighters regularly clashed for ideological reasons (Brown and Rassler, 2013, 147-174). However, both ISIS and the Haqqani Network were well managed despite being

[14]Admittedly, treating organizing a one-off cost is likely an underestimation; a principal may initially form a heterogeneous team, but once operating, some teammates may undermine the team structure. In practice, dictating organizational structure likely comes with more than a one-off cost, but would require less involvement than monitoring the day-to-day actions of the teams.

[15]On a heterogeneous team, agents receive less utility than they would on a homogeneous team

staffed by a diverse set of foreign and local agents (Lilleby, 2013; Gates and Podder, 2015).

In 2007, US led Coalition forces in Iraq denied AQI safe havens and commanded an effective joint military and government task force that captured or killed dozens of AQI's leaders (Schram, 2019); as a result, AQI embraced the Hands-Off Technique. Consistent with the equilibrium, domestic mid-level leadership began excluding foreign fighters from operations (CTC, 2007c) and members of AQI undertook a range of behaviors consistent with subversion (Fishman, 2009). For example, as AQI's leadership was reaching out to form an alliance with Ansar al-Sunnah, low-level members of AQI were killing members of Ansar al-Sunnah (CTC, 2007c,b). AQI's use of the Hands-Off Technique had consequences. On one hand, AQI's violent and criminal behavior encouraged local Sunni actors to join the "Awakening" movement, which played a major role in AQI's decline 2007-2010 (Biddle *et al.*, 2012). On the other hand, enough of AQI's leadership was able to survive, and these survivors led the re-emergence of AQI as ISIS (Weiss, 2015, 114-130).

To the best of my knowledge, there is no direct record of insurgent groups using the Incentive Contracts Techique to resolve subversion, with Bahney *et al.* (2013) explicitly discussing that AQI circa 2007 did not use this technique. It could be that, due to factors explored within the model – the high per-period monitoring – or factors outside of those contained in the model – like difficulties implementing precise transfers to agents in organizations where grifting is common (Shapiro and Siegel, 2012) –inefficiencies stemming from the agents' non-linear utility functions – incentive contracts are too difficult to broadly implement in the insurgency setting. However, some versions of this technique are found in illicit groups. For example, those funding Somali pirates offer bonuses to agents who undertake especially risky or difficult tasks – like a $10,000 bonus for being the first person to board the ship that is being hijacked (Blanc, 2013).

It is not clear if any insurgent groups actually use the Heterogeneous Teams with Incentive Contracts Technique. It is possible to imagine a young or small militant group that is large enough to merit the principal-agents treatment while still being small enough so that the principal can monitor agents' activities, provide flexible transfers, know the recruits' types, and change the organizational structure at will. In the licit sector, this is more common – with young companies or sports teams using combinations of dictating organizational structure with performance based incentives.

5 Considering the "Perfectly Aligned" Agent

The anti-ally-principle type results thus far have considered limited changes in agents' ideal points. A natural intuition is that the principal could form a better self-managing team if one of the misaligned agents were replaced by a subordinate whose preferences are fully in-line with the preferences of the principal. However, this intuition does not hold. Put another way, if the principal had a choice between an agent who valued exactly what the principal valued and a foreign fighter to act as teammate to a domestic fighter, in many cases, the principal can do strictly better selecting the foreign fighter. As intuition, creating a team of a domestic agent and a perfectly aligned agent removes much of the useful strategic tension that exists between foreign and domestic teammates. Adding the perfectly aligned agent can be valuable, but its value is derived largely from ally-principle type results rather than from the strategic interactions between teammates.

I will consider a "perfectly aligned" agent, who has utility function

$$U_{pa} = \sum_{t=1}^{\infty} \delta^{t-1} \left(-(\alpha+\gamma)|a_{pa,t} - \omega_t| - \beta|a_{j,t} - \omega_t| \right),$$

and will select actions $a_{pa,t} = (1 - z_{pa})\omega_t + z_{pa}\chi_d$. When $z_{pa} = 0$, the perfectly aligned agent is selecting their most preferred action (which is also the principal's most preferred action), and when $z_{pa} > 0$, the perfectly aligned agent is selecting actions closer to their domestic partner's ideal point. In equilibrium, a perfectly aligned agent and a domestic agent will set $\check{z}_1$ and $\check{z}_{pa}$, which I introduce then describe below.

Definition: $\check{z}_1$ and $\check{z}_{pa}$ are defined as

- $\check{z}_1 = 0$ and $\check{z}_{pa} = 0$ if $\check{k}_d \check{k}_{pa} < 1$ and
- $\check{z}_1 = 1$ and $\check{z}_{pa} = \frac{1}{\check{k}_d}$ if $\check{k}_d \check{k}_{pa} \geq 1$,

where $\check{k}_d = \frac{-\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)}$ and $\check{k}_{pa} = \frac{-\beta\chi_d\delta}{(\alpha+\gamma)(1-\delta-\chi_d)}$.

Using a Nash reversion punishment phase following deviations from equilibrium behavior, agent 1 is willing to shade up to $z_1 \leq min\left\{1, z_{pa}\check{k}_d\right\}$, and the perfectly aligned agent is willing to shade up to $z_{pa} \leq min\left\{1, z_1\check{k}_{pa}\right\}$. Because here each agent's level of shading is an increasing function of their teammate's level of shading, when the perfectly aligned agent selects $z_{pa} > 0$, it can induce agent 1 to select an action that is closer to the principal's ideal point to an extent that may outweigh the disutility that the principal receives from $z_{pa} > 0$. Thus, selecting $z_{pa} > 0$ can follow from the maximization criterion on Assumption 1, and this occurs when $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)} > 1$ holds,[16] which always holds under the conditions in the second bullet point. I can then define equilibrium behavior and the principal's payoffs in Proposition 5.

Proposition 5: Assume the principal forms a heterogeneous team with one domestic and one perfectly aligned agent.

- Agents set $a_{1,t} = \check{z}_1\omega_t + (1-\check{z}_1)\chi_d$ and $a_{pa,t} = (1-\check{z}_{pa})\omega_t + \check{z}_{pa}\chi_d$ for all t,
- $\mathbb{E}U_p = \left((1-\check{z}_1)\chi_d - \check{z}_{pa}(\omega_t - \chi_d)\right)/(1-\delta) - \kappa$.

Proof: See Appendix.

[16]This condition is derived in the Appendix and follows from taking first order conditions of the principal's utilty function with respect to agent 1's level of shading.

To compare the foreign-domestic team to the domestic-perfectly-aligned team (comparing Proposition 5 to Proposition 1), I must consider three distinct cases. First, when $\tilde{k}_f \geq 1$ (with $\tilde{k}_f$ defined preceding Proposition 1), then the domestic-foreign team is fully self-managing with both agents setting $a_{i,t} = \omega_t$. When this occurs, the foreign-domestic always outperforms the domestic-perfectly-aligned team, which never sets $a_{1,t} = a_{2,t} = \omega_t$. Second, when $\tilde{k}_d\tilde{k}_f < 1$, then there is no productive shading occurring within the domestic-foreign team, meaning that replacing a foreign agent with a perfectly aligned agent will produce efficiency gains through ally-principle type results. Finally, when $\tilde{k}_d\tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$, sometimes the domestic-perfectly-aligned team outperforms the domestic-foreign team, while at other times it does not.

6 Extensions

6.1 Agents Maximize Joint Utility (Modifying Assumption 1)

A natural concern with Assumption 1 is that it selects one equilibrium that is particularly good for the principal. As a simple alternative, I consider the case where agents maximize their team's per-period expected utility. This is equivalent to assuming that agents could side-contract to one another and not be concerned with hold-up problems. I compare the Incentive Contracts Technique used on a team of domestic agents[17] to the heterogeneous teams technique. Relative to Assumption 1, when agent's maximize their per-period utility, Heterogeneous Teams induce a greater degree of self-management across a larger parameter space, while Incentive Contracts to domestic agents become more costly for the principal.

Proposition 6: Assume that agents maximize their joint per-period utility:

[17] By limiting analysis to incentive contracting to domestic agents, the principal avoids the case where, after a set of incentive contracts designed for domestic agents is set, agent 1 selects a foreign type agent to obtain a greater team utility.

- Within the Incentive Contracts Technique, for agents $i \in \{1, 2\}$ and $j \in \{1, 2\}$ with $i \neq j$, the Principal transfers $G_{i,t} = (\alpha - \gamma)(a_{i,t} - \chi_d) + \beta(a_{j,t} - \chi_d)$. Agents set $a_{i,t} = \omega_t$. The principal receives expected payoff $EU_p = (2\chi_d(\alpha + \beta - \gamma) - \zeta)/(1 - \delta)$.
- Within the Heterogeneous Teams Technique, if $1 \leq (\beta)/(\alpha - \gamma)$ agents select $a_{i,t} = \omega_t$ and the principal receives expected payoff $EU_p = -\kappa$; otherwise, agents select $a_{1,t} = \chi_d$ and $a_{2,t} = \chi_f$ and the principal receives expected payoff $EU_p = (\chi_d - \chi_f)/(1 - \delta) - \kappa$.

Proof: See Appendix.

For a heterogeneous team under Assumption 1, for any shading to occur, the condition $\tilde{k}_d \tilde{k}_f \geq 1$ must hold (as described in Proposition 1). For a heterogeneous team under the assumptions here, agents will match their action to the principal's ideal point when $1 \leq \frac{\beta}{\alpha - \gamma}$ holds, which, based on conditions described in Assumption 0, is both easier to satisfy than $\tilde{k}_d \tilde{k}_f \geq 1$ and generates more favorable degree of shading for the principal. Put another way: even if agents are disregarding what the principal wants, by maximizing their joint utility, they will, under a broader parameter set, do precisely what is best for the principal.

In contrast, changing from Assumption 1 to the assumption that agents maximize their joint utility, Incentive Contracts become worse for principal. Comparing Proposition 3 to Proposition 6, here the principal must pay each agent i an additional $\beta(a_{j,t} - \chi_d)$ (with $j \neq i$) to get agents to match their actions to the state of the world. While a transfer of $(\alpha - \gamma)(a_{i,t} - \chi_d)$ will make agent i indifferent over any action $a_{i,t} \in [\chi_d, \omega_t]$, agent i can still benefit when their teammate selects action χ_d (relative to action ω_t). Here the additional $\beta(a_{j,t} - \chi_d)$ transfer is necessary to make the team of agents jointly indifferent over any action $a_{i,t} \in [\chi_d, \omega_t]$.

6.2 Expanding the Agents' Action Sets (Modifying Assumption 1)

Referring back to the definition of a shading equilibrium, I previously limited $z_i \in [0, 1]$. Here I assume $z_i \geq 0$, meaning agents are still following the shading structure as earlier, but here agents can select actions beyond the state of the world relative to their ideal point. I will refer to shading levels $z_i > 1$ as "over-shading" because, *ceteris paribus*, it describes the case where agent i shades beyond the level that the principal would most prefer that agent i undertakes ($z_i = 1$). To summarize what is to come, letting $z_i \geq 0$ opens a new degree of freedom in the maximization criterion within Assumption 1, which can lead to better outcomes for the principal. In equilibrium, allowing for overshading, a team with a domestic and foreign type agent will select shading levels $\mathring{z}_1$ and $\mathring{z}_2$, which I introduce then describe below.

Definition: $\mathring{z}_1$ and $\mathring{z}_2$ are defined as

- $\mathring{z}_1 = \tilde{z}_1$, $\mathring{z}_2 = \tilde{z}_2$ if $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} \leq 1$ or $\tilde{k}_f \geq 1$,
- $\mathring{z}_1 = \tilde{z}_1$, $\mathring{z}_2 = \tilde{z}_2$ if $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$, $\tilde{k}_f < 1$, and $0 < \mathring{k}_d \leq 1$,
- $\mathring{z}_1 = \mathring{k}_d$, $\mathring{z}_2 = \mathring{k}_f$ if $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$, $\tilde{k}_f < 1$, and $1 < \mathring{k}_d < \frac{1}{\tilde{k}_f}$,
- $\mathring{z}_1 = \frac{1}{\tilde{k}_f}$, $\mathring{z}_2 = 1$ if $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$, $\tilde{k}_f < 1$, and $\mathring{k}_d \geq \frac{1}{\tilde{k}_f}$,
- $\mathring{z}_1 = \frac{1}{\tilde{k}_f}$, $\mathring{z}_2 = 1$ if $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$, $\tilde{k}_f < 1$,
  and $(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d) \leq -\beta^2\chi_f\chi_d\delta^2$,

where $\mathring{k}_d = \frac{2\gamma(\alpha-\gamma)(\chi_f+1-\delta)(1-\delta-\chi_d)}{(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d)+\beta^2\chi_f\chi_d\delta^2}$ and $\mathring{k}_f = \frac{-2\gamma\beta\delta\chi_d(1-\delta-\chi_d)}{(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d)+\beta^2\chi_f\chi_d\delta^2}$.

Using a Nash reversion punishment phase following deviations from equilibrium behavior, agent 1 is willing to overshade (in other words, so long that $z_1 > 1$) at levels $z_1 \leq \frac{2\gamma}{\alpha+\gamma} + z_2\frac{\beta\chi_f\delta}{(\alpha+\gamma)(1-\delta-\chi_d)}$, and agent 2 is willing to shade (in other words, so long that $z_2 \leq 1$) at levels $z_2 \leq z_1\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)}$.[18] Because each

[18] Solving these expressions for one another yields the $\mathring{k}_d$ and $\mathring{k}_f$ terms.

agent's willingness to shade is an increasing functions of their teammates level of shading, when the domestic agent selects $z_1 > 1$, it can induce the foreign agent to select an action that is closer to the principal's ideal point to an extent that may outweigh the disutility the principal receives from $z_1 > 1$. Thus, selecting $z_1 > 1$ can follow from the maximization criterion in Assumption 1, and this occurs when $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$ holds.[19]

Allowing for overshading sometimes does not induce any change in behavior (the first two bullet points), while at other times can produce efficiency gains for the principal (the remaining bullet points) For the first bullet point, overshading is not productive for the principal. When $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} \leq 1$, the expression $-|a_{1,t}(z_1)-\omega_t|-|a_{2,t}(z_2)-\omega_t|$ is not maximized through overshading, and when $\tilde{k}_f \geq 1$, overshading is unnecessary because both agents are willing to always set $a_{i,t} = \omega_t$ when placed on a heterogeneous team. For the second bullet point, overshading would be productive ($\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$ and $\tilde{k}_f < 1$), but no feasible level of overshading is possible ($\mathring{k}_d \leq 1$). For the third bullet point, overshading is productive and agent 1 is willing to overshade, but agent 1 is unwilling to overshade to the degree such that agent 2 will match their action to the state of the world ($\mathring{z}_1 = \mathring{k}_d < \frac{1}{\tilde{k}_f}$, which induces $\mathring{z}_2 = \mathring{k}_f < 1$). In the forth bullet point, overshading is productive, agent 1 is willing to overshade, to the point where agent 2 matches their actions to the state of the world ($\mathring{z}_1 = \frac{1}{\tilde{k}_f}$, which induces $\mathring{z}_2 = 1$). In the final bullet point, overshading is productive, and the final inequality implies that $\frac{-\beta^2\delta^2\chi_f\chi_d}{(\alpha+\gamma)(1-\delta-\chi_d)(\alpha-\gamma)(\chi_f+1-\delta)} \geq 1$; when this is the case, agent 1 will always be willing to overshade to the level where $\mathring{z}_1 = \frac{1}{\tilde{k}_f}$.

I define equilibrium behavior and the principal's payoffs in Proposition 7.

Proposition 7: Assume $z_i \geq 0$. Under the Heterogeneous Teams Technique,

- Agents set $a_{1,t} = \mathring{z}_1\omega_t + (1-\mathring{z}_1)\chi_d$ and $a_{i,t} = \mathring{z}_2\omega_t + (1-\mathring{z}_2)(\chi_f)$ for all t,

[19] This condition is derived in the Appendix and follows from taking first order conditions of the principal's utility function with respect to agent 1's level of shading.

- $\mathbb{E}U_p = \left((1-\mathring{z}_1)\chi_d - (1-\mathring{z}_2)\chi_f\right)/(1-\delta) - \kappa$.

Proof: See Appendix.

As an important follow-up to Proposition 7, the Appendix shows that increasing χ_d can result in worse outcomes for the principal. Also in the Appendix, I include a discussion on shading equilibria.

6.3 Raising the Reservation Utility (Modifying Assumption 2)

In the Appendix, I also analyze a model where Assumption 2 does not hold, and the principal must pay a flat rate across techniques to induce agents to remain in the terror group. To summarize what occurs when the agents' reservation utility binds, sometimes the principal must offer larger transfer amounts to agents within the Heterogeneous Teams Technique relative to the Incentive Contracts Technique. However, because transfers in the Heterogeneous Teams Technique can be flat-rate transfers that are not conditioned on the agents' actions, the principal avoids the per-period ζ payment, which can make Heterogeneous Teams less expensive than Incentive Contracts.

7 Conclusion

Overall, the model presents a simple intuition for how self-managing teams can function. When left to their own devices, agents exhibit homophily and will at times subvert to the mutual benefit of their like-minded teammates. In contrast, when the principal requires that agents with different preferences work together, agents suffer when their different-type teammates subvert. On a diverse team, agents may find a mutually beneficial point of compromise by not subverting. While organizing a diverse team is not always possible – sometimes management cannot feasibly reach out to agents to insure diverse teams form – forming diverse teams represents a low-cost way to mitigate agency problems. And, as the analysis above shows, this result is robust to a variety of assumptions and modeling technologies.

In some cases, what encourages different types of agents to self-manage is surprising. The key result – as described in Observation 1 and explored in the "Perfectly Aligned Agent" example – suggests that the principal will not always seek out agents that are the most aligned with themselves; rather, in contrast to standard ally-principle type results, the principal can achieve efficiency gains by utilizing fringe agents that can offset the preferences of other agents within the organization.

The results here apply to subversion settings where constrained leadership must design effective teams from imperfect agents to operate in complex environments. The results that diversity is valuable may not apply to similar settings where leadership is less restricted. For example, many Western militaries deploy a hierarchy where leadership empowers one (or several) closely aligned agent to monitor proximate agents and to recommend rewards or punishments. This model better describes cases where leaders face external, bureaucratic, or organizational constraints – factors like counterinsurgency pressure, explicit rules on how the leadership can interact with agents, or a leader overseeing massive organization – where the primary interaction for agents is between similarly empowered teammates rather than between the agent and a defined leader. While a thorough discussion of alternate cases of the model is beyond the scope of this paper, this model could also describe the behavior of various government agencies staffed by multiple types of agents (for example, the economists and lawyers in the FTC, see Wilson 1989). Alternatively, this model could describe how to create more effective teams of police forces or aid workers. Additionally, this model could describe the agency problems in large corporations when managers want to fund specific pet projects, or in multinational corporations when managers want to over-invest capital development in regions where they have ties to.

My analysis suggests several avenues for future work. One possibility is to analyze how the principal can allocate funds to specific agents to make their actions have more impact, and what effect this has on the efficiency of self-managing teams. Another is to consider how the principal may experiment with team composition in settings where agents possess unknown utility functions.

References

al Zarqawi, A. M. (2004) Al-zarqawi's message to the fighters of jihad in iraq on september 11, 2004.

Baccara, M. and Bar-Isaac, H. (2008) How to organize crime, *The Review of Economic Studies*, **75**, 1039–1067.

Bahney, B. W., Iyengar, R. K., Johnston, P. B., Jung, D. F., Shapiro, J. N. and Shatz, H. J. (2013) Insurgent compensation: Evidence from iraq, *American Economic Review*, **103**, 518–22.

Battaglini, M. (2002) Multiple referrals and multidimensional cheap talk, *Econometrica*, pp. 1379–1401.

Bendor, J., Glazer, A. and Hammond, T. (2001) Theories of delegation, *Annual review of political science*, **4**, 235–269.

Berman, E. and Laitin, D. D. (2008) Religion, Terrorism and Public Goods: Testing the club model, *Journal of Public Economics*, **92**, 1942–1967.

Beyerlein, M. M. and Johnson, D. A. (1994) *Advances in interdisciplinary studies of work teams: Theories of self-managing work teams, Vol. 1.*, Elsevier Science/JAI Press.

Biddle, S., Friedman, J. A. and Shapiro, J. N. (2012) Testing the Surge: Why Did Violence Decline in Iraq in 2007?, *International Security*, **37**, 7–40.

Blanc, J.-B. (2013) *The pirates of Somalia: Ending the threat, rebuilding a nation*, International Bank for Reconstruction and Development, The World Bank.

Bonatti, A. and Rantakari, H. (2016) The politics of compromise, *American Economic Review*, **106**, 229–59.

Brown, V. and Rassler, D. (2013) *Fountainhead of Jihad*, Hurst & Company, London.

Chai, S. (1993) An organizational economics theory of antigovernment violence, *Comparative Politics*, pp. 99–110.

Che, Y. and Yoo, S. (2001) Optimal incentives for teams, *American Economic Review*, **91**, 525–541.

Crenshaw, M. (1987) Theories of terrorism: Instrumental and organizational approaches, *The Journal of strategic studies*, **10**, 13–31.

CTC (2007a) Analysis of the State of ISI, Tech. rep., Combating Terrorism Center, West Point, NY.

CTC (2007b) Letter from Abu Hamza to Ansar al-Sunnah Highlighting Divisions s between Abu Hamza and a member of al-Ansar, Tech. rep., Combating Terrorism Center, West Point, NY.

CTC (2007c) Letters to the Leadership of ISI about Issues of Single-party Control, Tech. rep., Combating Terrorism Center, West Point, NY.

Dewatripont, M. and Tirole, J. (1999) Advocates, *Journal of political economy*, **107**, 1–39.

Dressler, J. A. (2010) *The Haqqani Network: From Pakistan to Afghanistan*, Institute for the Study of War.

Enders, W. and Jindapon, P. (2010) Network Externalities and the Structure of Terror Networks, *Journal of Conflict Resolution*, **54**, 262–280.

Felter, J. and Fishman, B. (2007) Al-qa'ida's foreign fighters in iraq: A first look at the sinjar records, Tech. rep., DTIC Document.

Fishman, B. (2009) Dysfunction and decline: Lessons learned from inside al-qa'ida in iraq, Tech. rep., DTIC Document.

Fishman, B. (2016) *The Master Plan: ISIS, al Qaeda, and the Jihadi Strategy for Final Victory*, Yale University Press.

Gates, S. (2002) Recruitment and allegiance the microfoundations of rebellion, *Journal of Conflict Resolution*, **46**, 111–130.

Gates, S. and Podder, S. (2015) Social media, recruitment, allegiance and the islamic state, *Perspectives on Terrorism*, **9**, 107–116.

Gibbons, R., Matouschek, N. and Roberts, J. (2013) Decisions in organizations, *The handbook of organizational economics*, pp. 373–431.

Gibbons, R. and Roberts, J. (2012) *The handbook of organizational economics*, Princeton University Press.

Gilligan, T. W. and Krehbiel, K. (1989) Asymmetric information and legislative rules with a heterogeneous committee, *American Journal of Political Science*, pp. 459–490.

Grillo, I. (2016) *Gangster warlords: Drug dollars, killing fields, and the new politics of Latin America*, Bloomsbury Publishing.

Hafez, M. M. (2010) Tactics, takfir and anti-muslim violence, *Self-inflicted Wounds: Debates and Division in Al Qaeda and its Periphery*, pp. 19–44.

Hamid, M. and Farrall, L. (2015) *The Arabs at War in Afghanistan*, Hurst.

Hegghammer, T. (2010) The Rise of Muslim Foreign Fighters: Islam and the Globalization of Jihad, *International Security*, **35**, 53–94.

Hirsch, A. V. and Shotts, K. W. (2015) Competitive policy development, *The American Economic Review*, **105**, 1646–1664.

Holmstrom, B. (1982) Moral hazard in teams, *The Bell Journal of Economics*, pp. 324–340.

Holmstrom, B. and Milgrom, P. (1990) Regulating trade among agents, *Journal of Institutional and Theoretical Economics ...*, **146**, 85–105.

Holmstrom, B. and Milgrom, P. (1991) Multitask principal-agent analyses: Incentive contracts, asset ownership, and job design, *JL Econ. & Org.*, **7**, 24–52.

Holmstrom, B. and Milgrom, P. (1994) The firm as an incentive system, *The American Economic Review*, **84**, 972–991.

Hong, L. and Page, S. E. (2001) Problem solving by heterogeneous agents, *Journal of Economic Theory*, **97**, 123–163.

Jackson, M. O. and Wilkie, S. (2005) Endogenous games and mechanisms: Side payments among players, *The Review of Economic Studies*, **72**, 543–566.

Kalyvas, S. (2006) The logic of violence in civil war, *Cambridge Studies in Comparative Politics, Cambridge University Press,*.

Kirdar, M. (2011) *Al Qaeda in Iraq*, Center for Strategic and International Studies.

Lazear, E. P. (1999) Globalisation and the market for team-mates, *Economic Journal*, pp. C15–C40.

Lilleby, L. W. (2013) The haqqani network: Pursuing feuds under the guise of jihad?, *CTX Global Ecco*, **3**.

Malet, D. (2010) Why foreign fighters?: Historical perspectives and solutions, *Orbis*, **54**, 97–114.

McChrystal, G. S. (2013) *My share of the task: A memoir*, Penguin.

Moghadam, A. and Fishman, B. (2010) Self-Inflicted Wounds: Debates and Divisions Within al-Qaeda and its Periphery, Tech. rep., Combating Terrorism Center, West Point, NY.

Scahill, J. (2015) The purge: How somalia's al shabaab turned against its own foreign fighters, *The Intercept*.

Schram, P. (2019) Managing insurgency, *Journal of Conflict Resolution*, p. 0022002719832963.

Segal, I. (1999) Contracting with externalities, *The Quarterly Journal of Economics*, **114**, 337–388.

Shapiro, J. (2019) Formal approaches to the study of terrorism, in *The Oxford Handbook of Terrorism* (Eds.) E. Chenoweth, R. English, A. Gofas and S. N. Kalyvas, Oxford University Press, Oxford, chap. 10, pp. 148–162.

Shapiro, J. N. (2013) *The Terrorists Dilemma: Managing Violent Covert Organizations*, Princeton University Press.

Shapiro, J. N. and Siegel, D. (2007) Underfunding in Terrorist Organizations, *International Studies Quarterly*, **51**, 405–429.

Shapiro, J. N. and Siegel, D. A. (2012) Moral Hazard, Discipline, and the Management of Terrorist Organizations, *World Politics*, **64**, 39–78.

Tirole, J. (1986) Hierarchies and bureaucracies: On the role of collusion in organizations, *JL Econ. & Org.*, **2**, 181–214.

Trotsky, L. (1971) 1905.

Weinstein, J. M. (2006) *Inside rebellion: The politics of insurgent violence*, Cambridge University Press.

Weiss, M. (2015) How isis picks its suicide bombers, *The Daily Beast website*, **16**.

Whiteside, C. (2016) New masters of revolutionary warfare: The islamic state movement (2002-2016), *Perspectives on Terrorism*, **10**, 4–18.

Wilson, J. Q. (1989) *Bureaucracy: What government agencies do and why they do it*, Basic Books.

Yeatts, D. E. and Hyten, C. (1998) *High-performing self-managed work teams: A comparison of theory to practice*, Sage.

Zedong, M. (1938) Problems of war and strategy, *Selected Works*, **2**, 224.

Zelin, A. (2018) Tunisian foreign fighters in iraq and syria, *The Washington Institute for Near East Policy*, **PN55**.

Online Appendix

A Full Equilibrium Strategies

I describe full equilibrium behavior within all techniques, and provide a more detailed discussion of the the Heterogeneous Teams with Incentive Contracts Technique.

A.1 Heterogeneous Teams Technique

In the first stage, the principal sets $o_p = f$, $m = 0$, and $G_1 = G_2 = 0$. Also in this stage, both agents set $b_i = a$. In the second stage, in period $t = 1$, each agent i who is type τ selects action $a_{i,t} = \tilde{z}_i \omega_t + (1 - \tilde{z}_i)\chi_\tau$, with $\tilde{z}_1$ and $\tilde{z}_2$ defined in the text. For periods $t > 1$, if in period $t - 1$ agents select the actions characterized by $\tilde{z}_1$ and $\tilde{z}_2$, then in period t agent i selects the action characterized by $\tilde{z}_i$. For periods $t > 1$, if in period $t - 1$ either agent deviates from selecting the actions characterized by $\tilde{z}_1$ or $\tilde{z}_2$, then agent i selects the actions characterized by $z_i = 0$ in period t and all future periods.

A.2 Hands-Off Technique

In the first stage, the principal sets $o_p = u$, $m = 0$, and $G_1 = G_2 = 0$. Also in this stage, Agent 1 sets $o_a = d$, and both agents set $b_i = a$. In the second stage, both agents set $a_{i,t} = \chi_d$ for all t ($z_1 = z_2 = 0$).

A.3 Incentive Contracts Technique

In the first stage, the principal sets $o_p = u$, $m = 1$, and $G_i(a_{i,t}) = (\alpha - \gamma)(a_{i,t} - \chi_d)$ for each agent i for all t. Also in this stage, Agent 1 sets $o_a = d$, and both agents set $b_i = a$. In the second stage, both agents set $a_{i,t} = \omega_t$ for all t ($z_1 = z_2 = 1$).

B Heterogeneous Teams with Incentive Contracts Discussion

To summarize what occurs, in the first stage, the principal sets $o_p = f$, $m = 1$, and $G_{1,t}(a_1) = \hat{g}_1^* (a_{1,t,} - \chi_d)$ and $G_{2,t}(a_2) = \hat{g}_2^* (\chi_f - a_{2,t,})$ for all t, where $\hat{g}_1^*$and $\hat{g}_2^*$ maximize the principal's expected utility from the agent's actions. I will refer to g_1 and g_2 as the "transfer constants." Also in this stage, both agents set $b_i = a$. In the second stage, in period $t = 1$, each agent i who is type τ selects action $a_{i,t} = \hat{z}_i \omega_t + (1 - \hat{z}_i)\chi_\tau$, with $\hat{z}_1$ and $\hat{z}_2$ defined in the appendix. For periods $t > 1$, if in period $t - 1$ agents select the actions characterized by $\hat{z}_1$ and $\hat{z}_2$, then in period t agent i selects the action characterized by $\hat{z}_i$. For periods $t > 1$, if in period $t - 1$ either agent deviates from selecting the actions characterized by $\hat{z}_1$ or $\hat{z}_2$, then agent i selects the actions characterized by $z_i = 0$ in period t and all future periods.

So long that $g_1 < \alpha - \gamma$ and $g_2 < \alpha - \gamma$,[20], in equilibrium agents will select shading levels $\hat{z}_1$ and $\hat{z}_2$, which I introduce then describe below.

Definition: $\hat{z}_1$ and $\hat{z}_2$ are defined as

- $\hat{z}_1 = 1$ and $\hat{z}_2 = 1$ if $\hat{k}_d \geq 1$ and $\hat{k}_f \geq 1$,
- $\hat{z}_1 = 1$ and $\hat{z}_2 = \hat{k}_f$ if $\hat{k}_d \hat{k}_f \geq 1$ and $\hat{k}_f < 1$,
- $\hat{z}_1 = \hat{k}_d$ and $\hat{z}_2 = 1$ if $\hat{k}_d \hat{k}_f \geq 1$ and $\hat{k}_d < 1$,
- $\hat{z}_1 = 0$ and $\hat{z}_2 = 0$ if $\hat{k}_d \hat{k}_f < 1$.

with $\hat{k}_d = \frac{\delta\beta\chi_f}{(\alpha-\gamma-g_1)(1-\delta-\chi_d)}$ and $\hat{k}_f = \frac{-\beta\delta\chi_d}{(\alpha-\gamma-g_2)(\chi_f+1-\delta)}$.

Given these actions, I modify expression (2) to define the set of transfer

[20] It is straightforward to show that the Principal would never want to make offers $g_1 \geq \alpha - \gamma$ or $g_2 \geq \alpha - \gamma$.

constants $(\hat{g}_1^*, \hat{g}_2^*)$ that the principal will select from:

$$(\hat{g}_1^*, \hat{g}_2^*) \in \underset{g_1 \geq 0,\, g_2 \geq 0}{arg\,max} \left\{ \left((1 - \hat{z}_1(g_1, g_2) + \hat{z}_1(g_1, g_2) g_1) \chi_d - (1 - \hat{z}_2(g_1, g_2) + \hat{z}_2(g_1, g_2) g_2) \chi_f \right) / (1 - \delta) \right\}. \tag{3}$$

Because the principal's optimization function is neither continuous nor optimized over a closed interval, a natural concern is that the principal's optimization problem does not attain its maximum. However, it does.

Lemma 1. The set of $(\hat{g}_1^*, \hat{g}_2^*)$ satisfying (3) is nonempty and satisfies $g_1 \leq \alpha - \gamma$ and $g_2 \leq \alpha - \gamma$.

Proof: See Section C.4.

With Lemma 1 in place, the principal's and agent's actions can be described.

Proposition 4: Within the Heterogeneous Teams with Incentive Contracts Technique):

- Agents set $a_{1,t} = (1 - \hat{z}_1(\hat{g}_1^*, \hat{g}_2^*))\chi_d + \hat{z}_1(\hat{g}_1^*, \hat{g}_2^*)\omega_t$, and $a_{2,t} = \hat{z}_2(\hat{g}_1^*, \hat{g}_2^*)\omega_t + (1 - \hat{z}_2(\hat{g}_1^*, \hat{g}_2^*))\chi_f$ for all $t \in \{1, 2, 3, ...\}$.
- $\mathbb{E}U_p = \left((1 - \hat{z}_1(g_1^*, g_2^*) + \hat{z}_1(g_1^*, g_2^*) g_1^*) \chi_d - (1 - \hat{z}_2(g_1^*, g_2^*) + \hat{z}_2(g_1^*, g_2^*) g_2^*) \chi_f - \zeta \right) / (1 - \delta) - \kappa$,
- $\mathbb{E}U_1 = \left(\alpha \hat{z}_1(g_1^*, g_2^*) \chi_d - \beta \left((1 - \hat{z}_2(g_1^*, g_2^*)) \chi_f - \chi_d \right) - \gamma \left((1 - \hat{z}_1(g_1^*, g_2^*))(\omega_t - \chi_d) \right) - \hat{g}_1^* \chi_d \right) / (1 - \delta)$,
- $\mathbb{E}U_2 = \left(-\alpha \hat{z}_2 \chi_f - \beta \left(\chi_f - (1 - \hat{z}_1(g_1^*, g_2^*)) \chi_d \right) - \gamma \left((1 - \hat{z}_2(g_1^*, g_2^*))(\chi_f - \omega_t) \right) + \hat{g}_2^* \chi_f \right) / (1 - \delta)$.

Proof: See Section C

A simple example can demonstrate that this Technique can give the principal greater utility than only using Incentive Contracts. Consider a case where $\chi_f =$

1 and $\chi_d = -1$, $\delta = 1$ and $\beta = 0.5$. Under the incentive contracts technique, the principal must offer, in expectation, $\alpha - \gamma$ per-period. If the principal formed mixed teams and also used incentive contracts, a expected transfer value of $\alpha - \gamma - 0.4$ per-period would compel agents to match their actions to the state of the world, which is a clearly smaller transfer value. Under these parameter values, for a low enough κ, this technique can outperform Incentive Contracts. Empirically, here the principal brings in a diverse range of agents and would have weakly less subversion than the Heterogeneous Teams Technique.

Observation 4. Let Assumptions 0-3 hold. Within the Heterogeneous Teams with Incentive Contracts Technique, the principal's expected utility is weakly decreasing in α and weakly increasing in β and γ.

Proof: See Section D

C Proving Propositions 1-4 and Lemma 1

C.1 Proving Propositions 1 and 4

Because Proposition 1 follows from the case of Proposition 4 when $g_1 = g_2 = 0$, I prove these simultaneously. Based on Assumption 1, in equilibrium, agents shade by $z_1 \in [0, 1]$ and $z_2 \in [0, 1]$, and deviations from the equilibrium path are met with the grim-trigger punishment phase of agents setting $a_{1,t} = \chi_d$ and $a_{2,t} = \chi_f$ for all t. Also by Assumption 1, Agents will select the largest degree of shading. I fix the principal's transfers at g_1 and g_2, assuming that $g_1 < \alpha - \gamma$ and $g_2 < \alpha - \gamma$.

To examine which equilibria can be sustained, I consider the cases when agents shade towards a state of the world that is furthest from their ideal point. These are the cases that present the greatest incentive for agents to defect. For agent 1 is $\omega_t = 1$ and for agent 2 is $\omega_t = -1$. I first define several values.

Agent 1's worst 1 period payoff ($\omega_t = 1$) for remaining on the equilibrium path is
$U_1^{ON,W} = -\alpha\left(z_1 + (1-z_1)\chi_d - \chi_d\right) - \beta\left(z_2 + (1-z_2)\chi_f - \chi_d\right) - \gamma\left(1 - (z_1 + (1-z_1)\chi_d)\right) + g_1\left(z_1 + (1-z_1)\chi_d - \chi_d\right)$,

Agent 1's expected per-period utility for remaining on the equilibrium path is
$U_1^{ON,EU} = -\alpha\left((1-z_1)\chi_d - \chi_d\right) - \beta\left((1-z_2)\chi_f - \chi_d\right) - \gamma\left(1 - ((1-z_1)\chi_d)\right) + g_1\left((1-z_1)\chi_d - \chi_d\right)$.

Agent 1's utility from an optimal deviation from $\omega_t = 1$ is
$U_1^{OFF,W} = -\alpha\left(\chi_d - \chi_d\right) - \beta\left(z_2 + (1-z_2)\chi_f - \chi_d\right) - \gamma\left(1 - \chi_d\right)$.

Agent 1's expected per-period utility from being in the Nash reversion punishment phase is
$U_1^{OFF,EU} = -\alpha\left(\chi_d - \chi_d\right) - \beta\left(\chi_f - \chi_d\right) - \gamma\left(-\chi_d\right)$

For agent 1 to remain on the equilibrium path, it must be that

$$U_1^{ON,W} + \frac{\delta}{1-\delta} U_1^{ON,EU} \geq U_1^{OFF,W} + \frac{\delta}{1-\delta} U_1^{OFF,EU},$$

which can be simplified to

$$z_1 \leq \frac{z_2 \delta \beta \chi_f}{(\alpha - \gamma - g_1)(1 - \delta - \chi_d)}.$$

A similar expression can be identified on the limits of z_2, which comes from considering agent 2 facing an $\omega_t = -1$. This is

$$z_2 \leq \frac{-z_1 \beta \delta \chi_d}{(\alpha - \gamma - g_2)(\chi_f + 1 - \delta)}.$$

These expressions are used to produce $\tilde{z}_1$ and $\tilde{z}_2$ for the Heterogeneous Teams

Technique, and $\hat{z}_1$ and $\hat{z}_2$ for the Heterogeneous Teams with Incentive Contracts Technique. It follows from the agent's utlity functions and reservation utilities that agents will both select $b_i = a$.

There are two items to note here. First, as g_1 and g_2 approach $\alpha - \gamma$, the right hand side of both expressions become greater than 1, meaning that transfers close to $\alpha - \gamma$ will not induce additional shading; in Lemma 1 I show that the pricnipal does strictly worse using transfer values close to $\alpha - \gamma$. Second, so long that $0 \leq g_i < \alpha - \gamma$, the z_1 and z_2 are always positive.

C.2 Proving Proposition 2

If agent 1 selected a foreign type agent, in the repeated second stage, agents would select the strategies defined in the Heterogeneous Teams Technique. Selecting into a heterogeneous team produces a lower expected utility for agent 1 than selecting a domestic type partner (comparing agent 1's utilities in Proposition 1 and Proposition 2).

It is stratiforward to see that a team of domestic type agents without recieving transfers does best setting $a_{1,t} = a_{2,t} = \chi_d$, and that the utiltiies from these actions exceeds each agent's reservation utility (making $b = a$ equilibrium behavior).

C.3 Proving Proposition 3

With the offered transfer schedule $G_i(a_{i,t}) = (\alpha - \gamma)(a_{i,t} - \chi_d)$ for both agents i, if agent 1 selected a foreign type agent, the foreign type agent would always set $a_{i,t} = \chi_f$. This is strictly worse for agent 1 than selecting a domestic type agent 2.

When agent 1 and agent 2 are domestic type agents and are offered transfers of $G_i(a_{i,t}) = (\alpha - \gamma)(a_{i,t} - \chi_d)$, they are indifferent over all actions $a_{i,t} \in [\chi_d, \omega_t]$ (put another way, they are indifferent all shading levels $z_i \in [0, 1]$), which makes any set of actions within that range an equilibrium. By the maximization criteron on Assumption 1, agents will select $z_1 = z_2 = 1$. It is straitforward to see that the utilities from setting $z_1 = z_2 = 1$ exceeds each agent's reservation utility (making $b = a$ equilibrium behavior).

C.4 Proof of Lemma 1:

I proceed by cases. In Cases 1 and 2, I define a closed set of (g_1, g_2) and show that all transfer constants outside of the set are either infeasible or strictly worse for the principal than values inside the closed set. I can then address any discontinuities to the principal's optimization function with the domain of the defined closed set, and I can show that in all cases a maximum still exists. In Case 3, I show that when the set I defined in the first case is empty, a unique maximum exists.

Case 1: $\frac{-\beta^2\delta^2\chi_d\chi_f}{(\alpha-\gamma)^2(1-\delta-\chi_d)(\chi_f+1-\delta)} < 1$ I define the set

$$\mathcal{G} = \left\{ \begin{array}{l} (g_1, g_2) \,:\, g_1 \geq 0,\, g_2 \geq 0,\, g_2 \leq \alpha - \gamma + \dfrac{\delta^2\beta^2\chi_f\chi_d}{(\alpha-\gamma)(1-\delta-\chi_d)(\chi_f+1-\delta)} \\ g_1 \leq \alpha - \gamma + \dfrac{\delta^2\beta^2\chi_f\chi_d}{(\alpha-\gamma)(1-\delta-\chi_d)(\chi_f+1-\delta)} \end{array} \right\} \tag{4}$$

which, by the Assumption of the case, is nonempty. Throughout the proof, I use values

$$g_1' = \alpha - \gamma + \frac{\delta^2\beta^2\chi_f\chi_d}{(\alpha-\gamma)(1-\delta-\chi_d)(\chi_f+1-\delta)}$$

and

$$g_2' = \alpha - \gamma + \frac{\delta^2\beta^2\chi_f\chi_d}{(\alpha-\gamma)(1-\delta-\chi_d)(\chi_f+1-\delta)}$$

where, by construction, $(g_1', g_2') \in \mathcal{G}$. As defined, g_1' is a useful value because when the principal sets $G_{1,t}(a_1) = g_1' * (a_{1,t,} - \chi_d)$ and $G_{2,t}(a_2) = 0$, then at these transfer values $\hat{k}_d * \hat{k}_f \geq 1$. Thus, any payment to Agent 1 greater than g_1' is over-paying because it will not change the agents' actions. A similar logic holds for $g_2 = g_2'$ and $g_1 = 0$.

To show that values of (g_1, g_2) that fall outside of $\mathcal{G}$ are strictly worse for the principal requires a fairly tedious discussion of multiple cases. Before getting into the necessary casework, I introduce some notation. I define these transfer value pairs as $(\bar{g}_1, \bar{g}_2)$. I will abuse notation and let $\chi_d = \chi_1$ and $\chi_f = \chi_2$ as, within this case, agent 1 is domestic and agent 2 is foreign. Also, throughout this section, I define $i, j \in \{1, 2\}$, where $i \neq j$. Before proceeding, one final note – I will consider cases where the principal "overpays" the agents: were it not for Assumption 1 (limiting to shading equilibria), there (a) would be open set issues where agents tries to select the largest or smallest action in an unbounded set, or (b) domestic agents may select actions larger than ω_t and foreign agents may select actions smaller than ω_t. In both cases, relaxing Assumption 2 would modify the process of the proof, but not the results.

When $\bar{g}_i \geq \alpha - \gamma$ and $\bar{g}_j \geq \alpha - \gamma$, the principal's transfers will induce agents to set agents set $a_{i,t} = a_{i,j} = \omega_t$ for all t. At transfer values g_i' and g_j', agents set $a_{i,t} = a_{i,j} = \omega_t$ for all t (equivalent actions) at a transfer rate that, by definition, is less than that defined in $(\bar{g}_1, \bar{g}_2)$.

When $\bar{g}_i > \alpha - \gamma$ and $\bar{g}_j \in [0, \alpha - \gamma)$, then the principal's transfers induce agent i to select $a_{i,t} = \omega_t$ and will eliminate agent i's ability to use the Nash reversion punishment,[21] which results in agent j setting $a_{j,t} = \chi_j$ At transfer values g_i' and $\bar{g}_j$, agent i will select $a_{i,t} = \omega_t$ and agent j will shade some degree $0 \leq \hat{z}_j \leq 1$ (weakly more favorable actions) at a transfer rate that, by definition, is less than that defined in $(\bar{g}_1, \bar{g}_2)$.

When $\bar{g}_i \in (g_i', \alpha - \gamma]$ and $\bar{g}_j \in [0, \alpha - \gamma)$, then the principal's transfers induce agent i to select $a_{i,t} = \omega_t$ while still allowing agent i the possibility of the Nash

[21] At these transfer values, it is no longer a Nash equilibrium to set $a_{i,t} = 0$.

reversion punishment, which results in agent j selecting some shading level $0 \leq \hat{z}_j \leq 1$. At transfer values g'_i and $\bar{g}_j$, agent i will select $a_{i,t} = \omega_t$ and agent j will shade some degree $0 \leq \hat{z}_j \leq 1$ (equivalent actions) at a transfer rate that, by definition, is less than that defined in $(\bar{g}_1, \bar{g}_2)$.

The examples above cover all possible transfer values falling outside of $\mathcal{G}$.

Having shown that all points outside of $\mathcal{G}$ are strictly worse for the principal, the original optimization problem is equivalent to optimizing over the closed set

$$(\hat{g}_1^*, \hat{g}_2^*) \in \underset{g'_1 \geq g_1 \geq 0,\, g'_2 \geq g_2 \geq 0}{arg\,max} \{((1 - \hat{z}_1(g_1, g_2) + \hat{z}_1(g_1, g_2)g_1)\chi_d - (1 - \hat{z}_2(g_1, g_2) + \hat{z}_2(g_1, g_2)g_2)\chi_f)\,/(1 - \delta)$$

This function possesses one discontinuity at $\hat{k}_d * \hat{k}_f = 1$. At this value, agents jump from not shading to some degree of shading; because the principal provides transfers when agents shade, based on the selected g_1 and g_2, at $\hat{k}_d * \hat{k}_f = 1$ the function could increase or decrease at the discontinuity. The principal's expected utility increases when the jump from not paying transfers (because agents set $\hat{z}_1 = 0$ and $\hat{z}_2 = 0$, the principal does not pay transfers) to paying transfers is productive and decreases when it is more cost than it it worth. I denote the set G'' as all pairs (g_1, g_2) such that $\hat{k}_d(g''_1) * \hat{k}_f(g''_2) = 1$. There are three sub-cases to consider here. First, consider if for all $(g''_1, g''_2) \in G''$ $EU_P(g_1 = 0,\, g_2 = 0) \leq EU_P(g_1 = g''_1,\, g_2 = g''_2)$. Note that the principal's expected utility from $g_1 = 0$ and $g_2 = 0$ is the same as the principal's utility from any (g_1, g_2) where $g_1 \leq g''_1$ and $g_2 \leq g''_2$, with one inequality holding strictly. In the first sub-case, the principal's optimization is upper semi-continuous and therefore attains its maximum over a closed set. Second, consider if some $(g''_1, g''_2) \in G''$ have the property $EU_P(g_1 = 0,\, g_2 = 0) > EU_P(g_1 = g''_1,\, g_2 = g''_2)$. Here the function is not upper semi-continuous, but the principal can either (a) select the (g''_1, g''_2) pair that does attain the maximum or (b) select the (g'''_1, g'''_2) where $\hat{k}_d(g'''_1) * \hat{k}_f(g'''_2) > 1$ that attains the maximum. Third, consider if for all $(g''_1, g''_2) \in G''$ $EU_P(g_1 =$

0, $g_2 = 0) > EU_P(g_1 = g_1'', g_2 = g_2'')$. Here the function is not upper semi-continuous, but the principal can either (a) select $g_1 = 0$ and $g_2 = 0$ which attains the maximum or (b) select the (g_1''', g_2''') where $\hat{k}_d(g_1''') * \hat{k}_f(g_2''') > 1$ that attains the maximum.

Case 2: $\frac{-\beta^2\delta^2\chi_d\chi_f}{(\alpha-\gamma)^2(1-\delta-\chi_d)(\chi_f+1-\delta)} \geq 1$ **and** $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)} < 1$ In this case, any transfer values $g_1 > 0$ and $g_2 > \alpha - \gamma + \frac{\beta\delta\chi_d}{(\chi_f+1-\delta)}$ is counterproductive. Thus the principal is optimizing a continuous function over a closed set, implying that a maximum exists.

Case 3: $\frac{-\beta^2\delta^2\chi_d\chi_f}{(\alpha-\gamma)^2(1-\delta-\chi_d)(\chi_f+1-\delta)} \geq 1$ **and** $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)} \geq 1$ When these hold, agents both setting $a_{i,t} = \omega_t$ is supported as an equilibrium without transfers. Thus, a maximum exists at $g_1 = g_2 = 0$. □

D Further Observations 1 and 4 Discussions

D.1 Additional Comparative Statics Within Observation 1

When $\tilde{k}_d\tilde{k}_f <$, the principal's expected utility is strictly increasing in χ_d and decreasing in χ_f. Within this range, agents do not shade and match their actions to their ideal points, meaning increases or decreases in χ_d and χ_f have direct effects on the agent's behavior, which directly affects the principal's utilities. It is worthwhile mentioning that if the principal ever through that parameter values were such that $\tilde{k}_d\tilde{k}_f < 1$, the principal would never use the Self-Managing Teams Technique because the principal could do strictly better by not incurring the κ cost and selecting the Hands-Off technique.

The cutpoint $\tilde{k}_d * \tilde{k}_f = 1$ separates the regions where agents do not shade from the regions where agents do shade. When χ_d decreases, for example, from χ_d to χ_d' with $\chi_d > \chi_d'$, and this results in a change from $\tilde{k}_d * \tilde{k}_f < 1$ to

$\tilde{k}_d * \tilde{k}_f \geq 1$, Agents change from setting $a_{1,t} = \chi_d$ and $a_{2,t} = \chi_f$ to $a_{1,t} = \omega_t$ and $a_{2,t} = \chi_f - \tilde{z}_2(\chi_f - \omega_t)$. This shift always implies that agents are now closer to matching the principal's ideal actions. However, when χ_f increases, for example, from χ_f to χ'_f with $\chi_f < \chi'_f$, and this results in a change from $\tilde{k}_d * \tilde{k}_f < 1$ to $\tilde{k}_d * \tilde{k}_f \geq 1$, Agents change from setting $a_{1,t} = \chi_d$ and $a_{2,t} = \chi_f$ to $a_{1,t} = \omega_t$ and $a_{2,t} = \chi'_f - \tilde{z}_2(\chi'_f - \omega_t)$. This shift can lead to worse outcomes for the principal because if χ'_f is sufficiently very large, the new action $\chi'_f - \tilde{z}_2(\chi'_f - \omega_t)$ can be further from the principal's ideal point than χ_f was.[22]

D.2 Proving Observation 4

By Lemma 1, there exists some nonempty set of transfer constants $(\hat{g}_1^*, \hat{g}_2^*)$ that maximizes the principal's expected utility function within the Heterogeneous Teams with Incentive Contracts Technique I denote $(\hat{g}_1^*(\alpha), \hat{g}_2^*(\alpha))$ for an optimal set of transfer constants under parameter α, and I consider two possible α parameters, $\bar{\alpha}$ and $\underline{\alpha}$, where $\bar{\alpha} > \underline{\alpha}$. I will show that, in all cases, $(\hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha}))$ generates a weakly lower expected utility than $(\hat{g}_1^*(\underline{\alpha}), \hat{g}_2^*(\underline{\alpha}))$. Across cases, the proof relies on $\hat{k}_d$ and $\hat{k}_f$ (and $\hat{k}_d\hat{k}_f$) being strictly decreasing in α and strictly increasing in $\hat{g}_1$ and $\hat{g}_2$, which follows from first order conditions.

First, consider the case where some $(\hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha}))$ leads to $\hat{k}_d(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha})) * \hat{k}_f(\bar{\alpha}, \hat{g}_2^*(\bar{\alpha})) < 1$. The principal's expected utility here is $U_p(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha}))$. As the first subcase, consider when, for transfer values $\hat{g}_1 = 0$ and $\hat{g}_2 = 0$, $\hat{k}_d(\underline{\alpha}, 0) * \hat{k}_f(\underline{\alpha}, 0) < 1$. Because the agents are not shading under $\bar{\alpha}$, $U_p(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha})) = U_p(\underline{\alpha}, 0, 0)$. And, because the principal selects an optimal transfer constant from the set that includes $\hat{g}_1 = 0$ and $\hat{g}_2 = 0$, I can claim $U_p(\underline{\alpha}, 0, 0) \leq U_p(\underline{\alpha}, \hat{g}_1^*(\underline{\alpha}), \hat{g}_2^*(\underline{\alpha}))$. By transitivity, in this subcase $\underline{\alpha}$ generates a weakly greater utility for the principal. As the second subcase, consider when, for

[22] For example, when $\delta = 0.9$, $\alpha = 1.5$, $\beta = 1$, $\gamma = 0.65$, $\chi_d = -1$ and $\chi_f = 1$, then $\tilde{k}_d * \tilde{k}_f = 0.927$, the agents will not shade and the principal will receive a per-period expected payoff of -2 from self-managing teams. However, if all other parameters remain the same and now $\chi_f = 6$, then $\tilde{k}_d * \tilde{k}_f = 1.00$, agent 2 shades by $\tilde{z}_2 = 0.174$, and the principal will receive per-period payoff -5.96.

transfer values $\hat{g}_1 = 0$ and $\hat{g}_2 = 0$, $\hat{k}_d(\underline{\alpha}, 0) * \hat{k}_f(\underline{\alpha}, 0) \geq 1$. Here agents are shading and the principal is not incurring any costs from transfers, so $U_p(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha})) < U_p(\underline{\alpha}, 0, 0)$. And, because the principal selects an optimal transfer value from the set that includes $\hat{g}_1 = 0$ and $\hat{g}_2 = 0$,I can claim $U_p(\underline{\alpha}, 0, 0) \leq U_p(\underline{\alpha}, \hat{g}_1^*(\underline{\alpha}), \hat{g}_2^*(\underline{\alpha}))$. By transitivity, in this subcase, $\underline{\alpha}$ generates a strictly greater utility for the principal.

Second, consider the case where some $(\hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha}))$ leads to $\hat{k}_d(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha})) * \hat{k}_f(\bar{\alpha}, \hat{g}_2^*(\bar{\alpha})) \geq 1$. I can define g_1' and g_2' as the following:

$$g_1' = \begin{cases} g_1' \text{ such that } \hat{k}_d(\underline{\alpha}, g_1') = \hat{k}_d(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha})) & \text{if } \hat{k}_d(\underline{\alpha}, 0) \leq \hat{k}_d(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha})) \\ 0 & otherwise \end{cases}$$

and

$$g_2' = \begin{cases} g_2' \text{ such that } \hat{k}_f(\underline{\alpha}, g_2') = \hat{k}_f(\bar{\alpha}, \hat{g}_2^*(\bar{\alpha})) & \text{if } \hat{k}_f(\underline{\alpha}, 0) \leq \hat{k}_f(\bar{\alpha}, \hat{g}_2^*(\bar{\alpha})) \\ 0 & otherwise \end{cases}$$

where, because $\hat{k}_d$ and $\hat{k}_f$ are decreasing in α and increasing in transfer constants, it must be that $g_1' \leq \hat{g}_1^*(\bar{\alpha})$ and $g_2' \leq \hat{g}_2^*(\bar{\alpha})$. Thus, $U_p(\bar{\alpha}, \hat{g}_1^*(\bar{\alpha}), \hat{g}_2^*(\bar{\alpha})) \leq U_p(\underline{\alpha}, g_1', g_2')$. Because the principal selects an optimal transfer value from the set that includes $\hat{g}_1 = g_1'$ and $\hat{g}_2 = g_1'$,I can claim $U_p(\underline{\alpha}, g_1', g_2') \leq U_p(\underline{\alpha}, \hat{g}_1^*(\underline{\alpha}), \hat{g}_2^*(\underline{\alpha}))$. By transitivity, $\underline{\alpha}$ generates a weakly greater utility for the principal. $\square$

E Perfectly Aligned Agent

E.1 Full Equilibrium Strategy

In period $t = 1$, the domestic agent (agent 1) selects $a_{1,t} = \check{z}_1\omega_t + (1 - \check{z}_1)\chi_d$ and the perfectly aligned agent selects $a_{pa,t} = (1 - \check{z}_{pa})\omega_t + \check{z}_{pa}\chi_d$, with $\check{z}_1$ and $\check{z}_{pa}$ defined in the text. For periods $t > 1$, if in period $t-1$ agents select the actions characterized by $\check{z}_1$ and $\check{z}_{pa}$, then in period t the domestic or perfectly aligned agent selects the action characterized by $\check{z}_1$ or $\check{z}_{pa}$ (respectively). For periods $t > 1$, if in period $t-1$ either agent deviates from selecting the actions characterized by $\check{z}_1$ and $\check{z}_{pa}$, then the domestic or perfectly aligned agent selects the action characterized by $\check{z}_1 = 0$ or $\check{z}_{pa} = 0$ (respectively) in period t and all future periods.

E.2 Proving Proposition 5

In equilibrium, agents shade by $z_1 \in [0, 1]$ and $z_{pa} \in [0, 1]$, and deviations from the equilibrium path are met with the grim-trigger punishment phase of agents setting $a_{1,t} = \chi_d$ and $a_{pa,t} = \omega_t$ for all t. The modification to Assumption 1 no longer implies that agents will select the largest degree of shading; rather they will select the degree of shading that benefits the principal the most. If the perfectly aligned agent selects $z_{pa} = 0$, then this will not induce any additional shading by the domestic agent. However, it can be possible for the perfectly aligned agent to move closer to agent 1's ideal point (set $z_{pa} > 0$) to induce agent 1 to shade closer to the state of the world in such a way that will benefit the principal.

Redefining terms used earlier, Agent 1's worst 1 period payoff ($\omega_t = 1$) for remaining on the equilibrium path is
$U_1^{ON,W} = -\alpha\left(1 - \chi_d - (1 - z_1)(1 - \chi_d)\right) - \beta\left((1 - z_{pa}) + \chi_d(z_{pa}) - \chi_d\right) - \gamma\left((1 - z_1)(1 - \chi_d)\right)$,

Agent 1's expected per-period utility for remaining on the equilibrium path is
$U_1^{ON,EU} = -\alpha\left((1 - z_1)\chi_d - \chi_d\right) - \beta\left(\chi_d z_{pa} - \chi_d\right) - \gamma\left(-(1 - z_1)\chi_d\right)$.

Agent 1's utility from an optimal deviation from $\omega_t = 1$ is
$U_1^{OFF,W} = -\beta\left((1 - z_{pa}) + \chi_d(z_{pa}) - \chi_d\right) - \gamma\left(1 - \chi_d\right)$.

Agent 1's expected per-period utility from being in the Nash reversion punishment phase is
$U_1^{OFF,EU} = \beta\chi_d + \gamma\chi_d$.

For agent 1 to remain on the equilibrium path, it must be that

$$U_1^{ON,W} + \frac{\delta}{1-\delta} U_1^{ON,EU} \geq U_1^{OFF,W} + \frac{\delta}{1-\delta} U_1^{OFF,EU},$$

which can be simplified to

$$z_1 \leq z_{pa} \frac{-\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)}.$$

A similar expression can be identified for the limits on z_{pa}, which comes when the perfectly aligned agent faces a realization of $\omega_t = 1$. This is the "worst-case" for the perfectly aligned agent because the equation for shading implies that any $z_{pa} > 0$ here will result in the largest move away from ω_t. Disregarding the terms associated with β in the first period, the perfectly aligned agent's worst 1 period payoff ($\omega_t = 1$) for remaining on the equilibrium path is
$U_{pa}^{ON,W} = (-\alpha - \gamma)\left(z_{pa}(1-\chi_d)\right),$

Agent 1's expected per-period utility for remaining on the equilibrium path is
$U_{pa}^{ON,EU} = (-\alpha - \gamma)\left(z_{pa}(-\chi_d)\right) + \beta\left(1 - z_1\right)\chi_d.$

Agent 1's utility from an optimal deviation from $\omega_t = 1$ is
$U_{pa}^{OFF,W} = 0.$

Agent 1's expected per-period utility from being in the Nash reversion punishment phase is
$U_{pa}^{OFF,EU} = \beta\chi_d.$

For agent 1 to remain on the equilibrium path, it must be that

$$U_{pa}^{ON,W} + \frac{\delta}{1-\delta} U_{pa}^{ON,EU} \geq U_{pa}^{OFF,W} + \frac{\delta}{1-\delta} U_{pa}^{OFF,EU},$$

which implies the following must hold.

$$z_{pa} \leq z_1 \frac{-\beta\chi_d\delta}{(\alpha+\gamma)(1-\delta-\chi_d)}.$$

When the above two equations hold with equality, z_1 and z_{pa} are how far a domestic agent and the perfectly aligned are willing to shade. For reasons similar to those expressed in the discussion on Proposition 1, non-zero levels of shading are possible when $\frac{\beta^2\chi_d^2\delta^2}{(\alpha+\gamma)(\alpha-\gamma)(1-\delta-\chi_d)^2} \geq 1$. Can increasing ever z_{pa} be beneficial for the principal? Re-writing the principal's expected per-period utility in terms of z_{pa} yields

$$U_p = (1 - \frac{-z_{pa}\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)})(\chi_d) + z_{pa}\chi_d,$$

where taking first order conditions yields

$$\frac{\partial U_p}{\partial z_{pa}} = \chi_d\left(\frac{\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)} + 1\right).$$

Thus, U_p is increasing in z_{pa} when $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)} > 1$ holds. Note that in order for $\frac{\beta^2\chi_d^2\delta^2}{(\alpha+\gamma)(\alpha-\gamma)(1-\delta-\chi_d)^2} \geq 1$, it must be that $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)} > 1$.

As a final note, when $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(1-\chi_d-\delta)} > 1$ holds, the principal does better having z_1 increase until it reaches the point where $z_1 = 1$ (agent 1 is matching action to the state of the world). Because $z_1 = z_{pa}\check{k}_d$, the principal does best up to the point where $z_{pa} = 1/\check{k}_d$. But is the perfectly aligned agent willing to make this shift? When $z_1 = 1$, the perfectly aligned agent is willing to shade up to $z_{pa} = \check{k}_{pa}$. Under the condition that $\check{k}_d\check{k}_{pa} \geq 1$, $\check{k}_{pa} \geq 1/\check{k}_d$, implying the perfectly aligned is willing to shade up to $1/\check{k}_d$.

Therefore, I can express the equilibrium levels of shading in regards to the $\frac{\beta^2\chi_d^2\delta^2}{(\alpha+\gamma)(\alpha-\gamma)(1-\delta-\chi_d)^2}$ condition, and use the above to produce equilibrium shading levels $\check{z}_1$ and $\check{z}_{pa}$.

E.3 Foreign-Domestic Team or Perfectly Aligned Agent-Domestic Team?

Here I provide a more detailed discussion on when the principal would prefer the foreign-domestic team over the perfectly aligned agent-domestic team. For ease, I refer to the domestic-foreign agent team as the D-F team and the domestic-perfectly aligned agent team as the D-PA team. I compare expected per-period utilities.

When $\tilde{k}_f \geq 1$, then the D-F team are setting $\tilde{z}_1 = \tilde{z}_2 = 1$, which grants the principal a greater expected utility than anything the D-PA team does. When $\tilde{k}_d \tilde{k}_f < 1$, then the D-F team is setting $\tilde{z}_1 = \tilde{z}_2 = 0$, which implies, for ally principle type reasons, the principal can do strictly better using the D-PA team.

For parameters where$\tilde{k}_d \tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$, then whether D-F teams or D-PA teams are better for the principal depends on whether one of two cases holds.

Case 1: $\frac{\beta^2 \chi_d^2 \delta^2}{(\alpha+\gamma)(\alpha-\gamma)(1-\delta-\chi_d)^2} < 1$

The D-F team is better for the principal when

$$-(1-\tilde{k}_f)\chi_f \geq \chi_d,$$

which can be re-written as

$$\chi_f \left(\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)} - 1 \right) \geq \chi_d.$$

To offer some intuition on this condition, this inequality can hold or break depending on χ_f. Logically, when the foreign type agent is very extreme (possessing a large χ_f), shading can still occur, but the foreign fighter's shading will not result in a selected action close to ω_t. For example, when $\alpha = 1$, $\beta = 0.8$, $\gamma = 0.7$, $\chi_d = -2$, $\delta = 0.9$ and $\chi_f = 5$, the principal's per-period expected utility from the D-F team is ≈ -0.29 (with $\tilde{z}_1 = 1$ and $\tilde{z}_2 \approx 0.94$) and the principal's expected utility from the D-PA team is -2 (with $\check{z}_1 = \check{z}_{pa} = 0$). However, keeping all parameters but χ_f the same, when $\chi_f = 10$, the principal has per-period expected utility from the D-F team is ≈ -5.24 (with $\tilde{z}_1 = 1$ and $\tilde{z}_2 \approx 0.48$) and the per-period expected utility from the D-PA team is still -2.

Case 2: $\frac{\beta^2\chi_d^2\delta^2}{(\alpha+\gamma)(\alpha-\gamma)(1-\delta-\chi_d)^2} \geq 1$

The D-F team is better for the principal when

$$-(1-\tilde{k}_f)\chi_f \geq \frac{1}{\check{k}_d}\chi_d,$$

Which can be re-written as

$$\chi_f\left(\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)} - 1\right) \geq \frac{(\alpha+\gamma)(1-\delta-\chi_d)}{-\beta\delta}.$$

Similar to the previous case, this inequality can hold or break depending on χ_f.

F Agents Maximize Joint Utility

F.1 Proving Proposition 6

By matching action to the state of the world, a team of domestic agents receives joint expected utility $2(\alpha+\beta)\chi_d$. My matching action to their ideal points, a team of domestic agents receives joint expected utility $2\gamma\chi_d$. therefore, to properly motivate agents to match actions to the state of the world, the principal must transfer $G_{i,t} = (\alpha-\gamma)(a_{i,t}-\chi_d) + \beta(a_{j,t}-\chi_d)$ to both agents, which combined is an expected per-period transfer of $2(\alpha+\beta-\gamma)\chi_d$.
By matching action to the state of the world, a team of one domestic and one foreign agent receives joint expected utility $(\alpha+\beta)(\chi_d-\chi_f)$. My matching

action to their ideal points, a team of domestic agents receives joint expected utility $-\beta(\chi_f - \chi_d) - \beta(\chi_f - \chi_d) - \gamma\chi_f + \gamma\chi_d$. Through algebra, the condition $1 \leq \beta/(\alpha - \gamma)$ must hold for a diverse team to fully self-manage.

G Expanding the Agent's Action Sets

G.1 Equilibrium Behavior

The equilibrium behavior is nearly identical to that for a heterogeneous team, only now with actions characterized by $\mathring{z}_1$ and $\mathring{z}_2$.

G.2 Proving Proposition 7

For reasons described in Proposition 1, agent 2's willingness to shade is $z_2 \leq \frac{-z_1\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)}$. When agent 1 selects a shading level $z_1 > 1$ (overshading), removing the β term and shading associated with it in the first period,[23] agent 1's worst 1 period payoff ($\omega_t = 1$) for remaining on the equilibrium path is $U_1^{ON,W} = -\alpha\,(1 - \chi_d - (1 - k_d)(1 - \chi_d)) - \gamma\,((k_d - 1)(1 - \chi_d))$,

Agent 1's expected per-period utility for remaining on the equilibrium path is $U_1^{ON,EU} = -\alpha\,((1 - k_d)\chi_d - \chi_d) - \beta\,((1 - k_f)\,\chi_f - \chi_d) - \gamma\,(-(k_d - 1)\chi_d)$.

Agent 1's utility from an optimal deviation from $\omega_t = 1$ (after removing the β term and shading associated with it) is $U_1^{OFF,W} = -\gamma\,(1 - \chi_d)$.

Agent 1's expected per-period utility from being in the Nash reversion punishment phase is $U_1^{OFF,EU} = -\beta\,(\chi_f - \chi_d) - \gamma\,(-\chi_d)$.

[23]Because this is the one-period deviation payoff, agent 1 receives the same payoff stemming from agent 2's actions whether or not agent 1 remains on the equilibrium path.

For agent 1 to remain on the equilibrium path, it must be that

$$U_1^{ON,W} + \frac{\delta}{1-\delta} U_1^{ON,EU} \geq U_1^{OFF,W} + \frac{\delta}{1-\delta} U_1^{OFF,EU},$$

which can be simplified to

$$z_1 \leq \frac{2\gamma}{\alpha+\gamma} + z_2 \frac{\beta\left(\chi_f\right)\delta}{(\alpha+\gamma)(1-\delta-\chi_d)}.$$

The question remains if agent 1 selecting actions $z_1 > 1$ is valuable for the principal. Within this case, with z_1 and z_2 defined as the conditions above holding with equality, the principal has expected per-period utility $-(1-z_2)\chi_f + (z_1 - 1)\chi_d$. Substituting in $z_2 = \frac{-z_1\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)}$ and taking first order conditions with respect to z_1, the principal benefits from agent 1 setting $z_1 > 1$ when

$$\chi_d \left(1 - \frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)}\right) > 0,$$

which informs the inequalities involving $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)}$.

The question also remains how far agent 1 is willing to shade. Substituting $z_2 = z_1 \frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)}$ into the expression $z_1 = \frac{2\gamma}{\alpha+\gamma} + z_2 \frac{\beta\left(\chi_f\right)\delta}{(\alpha+\gamma)(1-\delta-\chi_d)}$[24] and solving for z_1 yields

$$z_1 = \frac{2\gamma(\alpha-\gamma)(\chi_f+1-\delta)(1-\delta-\chi_d)}{(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d) + \beta^2\chi_f\chi_d\delta^2},$$

and a comparable equation can be solved for z_2 which is

$$z_2 = \frac{-2\gamma\beta\delta\chi_d(1-\delta-\chi_d)}{(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d) + \beta^2\chi_f\chi_d\delta^2}.$$

[24] Readers might wonder why in proposition 1 I did not substitute the comparable terms into one another. In the heterogeneous teams with no overshading, because agent 1 only shaded up to 1 and because agent 2 would never select a non-zero level of shading if $\tilde{k}_d < 1$, the expression would not have been correct. Here because agent 1 is selecting a level of $\frac{(\alpha-\gamma)(\chi_f+1-\delta)}{\beta\delta\chi_d} \geq z_1 > 1$, actually solving for this expression is necessary.

There are two things to note about these conditions. First, because any level of shading $z_2 > 1$ becomes unproductive for the principal, agent 1 will not select a shading level beyond $z_1 = \frac{(\alpha-\gamma)(\chi_f+1-\delta)}{-\beta\delta\chi_d}$. Therefore, when $\frac{(\alpha-\gamma)(\chi_f+1-\delta)}{\beta\delta\chi_d} < \frac{2\gamma(\alpha-\gamma)(\chi_f+1-\delta)(1-\delta-\chi_d)}{(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d)+\beta^2\chi_f\chi_d\delta^2}$, agent 1 will only shade to $z_1 = \frac{(\alpha-\gamma)(\chi_f+1-\delta)}{\beta\delta\chi_d}$. Second, the denominator in z_1 and z_2 as defined above $((\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d)+\beta^2\chi_f\chi_d\delta^2)$ is not necessarily positive or non-zero. However, when $(\alpha-\gamma)(\chi_f+1-\delta)(\alpha+\gamma)(1-\delta-\chi_d)+\beta^2\chi_f\chi_d\delta^2 \leq 0$, it implies that $\frac{-\beta\delta\chi_d}{(\alpha-\gamma)(\chi_f+1-\delta)} * \frac{\beta(\chi_f)\delta}{(\alpha+\gamma)(1-\delta-\chi_d)} \geq 1$, which implies that each agent is willing to shade at a level greater than that of their teammate; this implies that overshading is always possible.

This discussion informs the equilibrium cases in the paper.

G.3 Partial Comparative Statics on χ_d

Whenever agent 1 and agent 2 select $\tilde{z}_1 = 1$ and $\tilde{z}_2 \in (0,1]$, the principal's expected utility is decreasing in χ_d. Does this hold for levels of overshading? The following case analysis relies on for any $z_1 > 1$ and $z_2 \in [0,1]$, the principal's expected utility is $U_p = -(1-z_2)\chi_f + (z_1-1)\chi_d$.

When $z_1 = \frac{(\alpha-\gamma)(\chi_f+1-\delta)}{-\beta\delta\chi_d} = \frac{1}{\mathring{k}_f}$, z_1 is increasing in χ_d. This means as χ_d increases, agent 1 shades more, which results in a lower expected utility for the principal (because in this case z_2 is unchanging).

When $z_1 = \mathring{k}_d$ and $z_2 = \mathring{k}_f$, the effect of changing χ_d on the principal's utility is ambiguous. Taking first order conditions and re-arranging yields

$$\frac{\partial U_p(\mathring{k}_d, \mathring{k}_f)}{\partial \chi_d} = \frac{2\gamma((\chi_f-\delta+1)(\alpha-\gamma)-\delta\beta\chi_f)\left((\alpha^2-\gamma^2)(\chi_f-\delta+1)(\chi_d+\delta-1)^2-\delta^2\left(\beta^2\right)\chi_f\chi_d^2\right)}{\left((-\chi_f+\delta-1)(\chi_d+\delta-1)(\alpha^2-\gamma^2)+\delta^2\beta^2\chi_f\chi_d\right)^2}$$

When the right hand side of the expression is negative, than the principal's expected utility is decreasing in χ_d. Admittedly, this statement is fairly complex, and I am unable to simply it further. However, using specified parameters, I am unable to find a case where, when $\frac{\beta\delta\chi_f}{(\alpha-\gamma)(\chi_f+1-\delta)} > 1$, $\tilde{k}_f < 1$, and $1 < \mathring{k}_d < \frac{1}{\tilde{k}_f}$ hold, where the first order conditions are positive. For example, when $\alpha = 1$, $\beta = 0.7$, $\gamma = 0.5$, $\chi_d = -1$, $\delta = 0.9$ and $\chi_f = 30$, the first order conditions are approximately -0.23. Whenever the first order conditions are negative, it implies that increasing χ_d makes the principal worse off, showing that non-ally principle type results remain in equilibrium with overshading.

G.4 Thoughts On Overshading

Empirically, it is difficult to know what to make of overshading equilibria. Overshading equilibrium have the undesirable feature where agent 1 selects an action that they dislike and that, as a first-order effect, is bad for the organization. While overshading is in aggregate beneficial for the principal (because of the strategic response it induces in agent 2), it is decidedly more complex. While "nudging" agents towards non-zero shading equilibrium with $z_i \in [0, 1]$ can be thought of as the principal encouraging agents to do what's best (or close to what's best) for the organization because other agents are doing the same, nudging agents towards overshading equilibria would require convincing agent 1 to undertake an action that they do not like and that does not immediately benefit the organization. While it is possible to imagine select cases where the necessary complex internal practices leading to overshading are possible, it is hard to imagine that this sort of overshading is commonplace.

H Raising the Reservation Utility

So far the agents have always done better by joining the group and participating in operations. Now I consider the case where the agents' reservation utility is raised to $R_a = 0$, which implies that the principal must pay a flat transfer rate across techniques to get agents to participate. Proposition 8 shows how this matters to the principal's utility across the Hands Off, Heterogeneous Teams, and Incentive Contracts Techniques. I do not discuss the agents' actions, as these remain the same as they are in preceding sections. To summarize what follows, when the agents' reservation utility binds, sometimes the principal must offer larger transfer amounts to agents within the Heterogeneous Teams Technique relative to the Incentive Contracts Technique. However, because transfers in the Heterogeneous Teams Technique can be flat-rate transfers that are not conditioned on the agents' actions, the principal avoids the per-period ζ payment, which can make Heterogeneous Teams less expensive than Incentive Contracts.

Proposition 8: Assume $R_a = 0$. To keep the agents from leaving the terror group:

- Within Incentive Contracts, the Principal transfers $G_{1,t} = (\alpha - \gamma)(a_{1,t} - \chi_d) - (\beta + \gamma)\chi_d$ and $G_{2,t} = (\alpha - \gamma)(a_{2,t} - \chi_d) - (\beta + \gamma)\chi_d$ for all $t \in \{1, 2, 3, ...\}$, and has $\mathbb{E}U_p = (2\chi_d(\alpha + \beta) - \zeta) / (1 - \delta)$,
- Within Hands-Off, the Principal transfers $G_{1,t} = -\gamma$ and $G_{2,t} = -\gamma$ for all $t \in \{1, 2, 3, ...\}$, and has $\mathbb{E}U_p = 2 (\chi_d - \gamma) / (1 - \delta)$,
- Within Heterogeneous Teams, the Principal transfers $G_{1,t} = -\alpha\tilde{z}_1\chi_d + \beta ((1 - \tilde{z}_2)\chi_f - \chi_d) + \gamma(1 - \tilde{z}_1)(-\chi_d)$ and $G_{2,t} = \alpha\tilde{z}_2\chi_f + \beta (\chi_f - (1 - \tilde{z}_1)\chi_d) + \gamma(1 - \tilde{z}_2)(\chi_f)$ for all $t \in \{1, 2, 3, ...\}$, and has $\mathbb{E}U_p = (2 (\chi_d - \gamma) - G_{1,t} - G_{2,t}) / (1 - \delta) - \kappa$.

Among the three techniques examined here, using the Hands-Off Technique requires the smallest level of transfers. When $z_1 = 1$ and $z_2 = 1$, Heterogeneous Teams requires a greater transfer amount than Incentive Contracts. However, when $\tilde{k}_d\tilde{k}_f \geq 1$ and $\tilde{k}_f < 1$, then sometimes Heterogeneous Teams requires a smaller expected per-period transfer. When $\tilde{k}_f < 1$, agent 2 is selecting an action that is closer to agent 2's ideal point, and therefore does not need to be compensated as much to match their reservation utility.

The key take-away from Proposition 8 is that even with a high reservation utility, the principal may still use self-managing teams. While the principal always pays more in the Heterogeneous Teams Technique than in the Hands-Off Technique, the agents will behave better when principal uses Heterogeneous Teams, which can justify the costs. While the the principal sometimes pays a larger expected per-period transfer in the Heterogeneous Teams Technique than in the Incentive Contracts Technique, the principal does not need to pay ζ each period, which can make Heterogeneous Teams overall cheaper. Ultimately, while different agents do not want to work together without being provided with greater compensation, paying out a greater compensation can be worth the costs.