Foreign Attacks on Space-Based Assets and Public Support for Retaliation

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April 5, 2024

Abstract

Are attacks by foreign actors against a country's space-based assets received differently than similar attacks against assets on the ground? We study this question using a survey experiment fielded on the American public. We present respondents with a scenario in which China attacks U.S. government communication systems. We vary the following elements: the domain of the attack (space vs. ground), method of attack (cyber vs. kinetic), and potential fatalities. After manipulation, we ask respondents to indicate their level of support for retaliatory measures ranging from breaking diplomatic relations to the use of military force. The results suggest the public does not view space-based conflict differently than conflict on the ground. However, individuals are more likely to support harsher retaliatory measures in response to kinetic attacks and attacks that produce fatalities.

Keywords: International Conflict, Domestic Politics of IR, Survey Experiments, Outer-Space, Cyber Conflict

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Several rich literatures in international relations suggest the public in democracies can both constrain and compel leaders as they consider responses to foreign aggression. The public may *compel* leaders by demanding action in the face of damage to infrastructure and the loss of life—a kind of "trip wire effect" (Schelling 1960).[3] At the same time, leaders in democracies are *constrained* by voters who have little patience for military operations that lack clear objectives and endpoints, incentivizing leaders to respond selectively and, when they do, to fight hard and effectively (Fearon 1994, Reiter and Stam 1998, Tomz 2007, Kertzer and Brutger 2016, Carter 2017, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019). While we have learned much from past work on the domestic politics of international conflict and foreign aggression, the emergence of both outer and cyberspace as domains of conflict has caused some scholars to question whether the arguments presented in these older literatures still apply (Petras 2002, Gartzke 2013, Kreps 2014, 2023, Horowitz 2020, Falco 2020). In particular, scholars have studied whether aggression in cyberspace "hits differently" because it is often not accompanied by the dramatic physical effects and imagery that attend kinetic attacks, and attribution is often more difficult. For similar reasons, others have questioned whether attacks on national assets in space are likely to mobilize the public to the same degree as attacks on national assets on the ground. While there has been much-informed speculation on these points, the observational record is quite thin. Moreover, if/when space-based and/or cyber conflicts do occur, our analyses of public responses are hampered, in the main, by strategic selection bias on the part of both foreign aggressors and leaders choosing how to respond (Schultz 2001).

In this paper, we sidestep these issues and make progress on a number of the questions about the domestic politics of space-based conflict using a survey experiment fielded on the U.S. public to study whether the public conditions its desired policy responses to foreign aggression

[3] Though see Musgrave and Ward 2022.

on the method of attack (cyber vs. kinetic) and/or the domain of the attack (outer space vs. on the ground). In our experiment, we studied how the public's support for a range of retaliatory options changes in response to attacks on ground- and space-based U.S. communication assets. We randomly assigned individuals to a hypothetical but plausible scenario in which China attacks U.S. military communication systems. While we fix the aggressor and type of target, we vary the location of the communications system (space or ground), type of attack used (cyber or kinetic), and time needed to repair the system (days or years). To benchmark the effect of these manipulations, we also included treatment conditions in the ground/kinetic scenarios in which U.S. military personnel are killed. Following treatment, we asked respondents to indicate their level of support for each of the following retaliatory measures: breaking of diplomatic ties, sanctions, cyber attacks, and kinetic attacks.

We find the difference between retaliatory support for ground- and space-based attacks to be both substantively and statistically insignificant. Foreign aggression in space, it seems, carries with it the same perception as a ground-based conflict in the minds of the American public. However, the public is about 12 percentage points more supportive of kinetic retaliation in response to kinetic attacks (relative to cyber attacks), whether those attacks occur against space-based or ground-based assets. We show that this effect is similar in magnitude to fifteen U.S. personnel being killed. These results contribute to the literature on the domestic politics of international conflict by showing that the public generally does not differentiate between foreign aggression against ground-based and space-based assets. At the same time, our results show the public conditions its willingness to retaliate (and how to do so) on the method and material consequences of an attack (Shandler et al. 2021, Leal and Musgrave 2022, Walsh 2015, Walsh and Schulzke 2015, McDonald and Walsh 2021).

Is Space Conflict Different?

There are no historical examples of state-on-state conflict in outer space. As a result, past empirical work on conflict in this new domain is quite limited. Several pieces attempt to broadly define the potential implications of both kinetic and non-kinetic warfare in outer space. Blake (2014) describes the military significance of a state's orbital assets, both governmental and commercial, and also theorizes the possibility of weapons targeting systems 'through', 'to', 'in', and 'from' space. Lubojemski (2019) identifies the dual-use nature of satellites in that they can be used for both civilian and military purposes. Adequately judging the intentions behind a rival's new satellite mission proves difficult due to its dual-use potential. Steer (2017) and Zhao and Jiang (2019) focus on the legal implications of conflict in outer space by referencing the Outer Space Treaty of 1967 as well as international norms, which ban nuclear weapons in outer space. While Steer points out the treaty's definition of space as a "global commons" free for all to use, Zhao and Jiang suggest the document allows for retaliation in space -or from space- in accordance with self-defense legal precedent. Today, the international regulatory framework for military action in space is still rapidly developing.

Cyberattacks, specifically, are seen by many as the preferred method of attack in the space domain (Petras 2002, McClure 2012, Bardin 2013, Falco 2020). Yet, the extent to which governments will utilize cyberwarfare to achieve their political agendas remains disputed. Gartzke (2013) argues cyber tools will simply augment the technical advantages of status quo powers instead of bringing about massive disruption to the international system. Brantly (2021) builds on the notion of cyberattacks eliciting a minimal response from states by pointing out the issues of credibility, attribution, escalation, and conflict management in a cyberwarfare scenario. Due to these issues, some scholars suggest a strong defense is often the best offense in the cyber

realm (McLaughin 2011, Gartzke 2013, Horowitz 2020). In addition to state-sponsored cyber attacks, several authors confront the possibility of cyber terrorism. Shandler et. al (2021) examine the results of a survey on public support for retaliation against cyber terror attacks and find that only lethal attacks ignite a strong appetite for retaliatory measures against the terrorists. In a similar study, Leal and Musgrave (2022) find that Americans are likely to support retaliation-in-kind to cyber attacks generally, but as the damage from a cyber attack mounts, individuals are willing to support harsher measures of retaliation such as economic or physical responses. Furthermore, the authors conclude that terrorist groups and foreign adversaries enact a stronger response from the public than lone wolf actors or activists. Other than having an effect on retaliation support, cyberattacks can also affect individuals' psychological state and their trust in their government (Shandler and Gomez 2022, Shandler et al. 2023).

Thus far, only a few works have directly addressed cyberattacks on satellites. Relating the possible loss of satellite capabilities from cyberattacks to outages caused by solar storms, Bardin (2013) presents a potential scenario in which the U.S. loses communication, command-and-control, and reconnaissance assets to a large-scale cyberattack on U.S. satellite systems. Such an event would cripple U.S. warfighting capabilities, at least temporarily. Falco (2020) examines the concept of satellite-on-satellite cyberattacks. With low-cost smallsats and cloud services available to almost any nation, cyberattacks originating from other orbital bodies demonstrates a new threat to national security. Legally speaking, a cyberattack on a U.S. satellite could ignite the same response as a kinetic attack, should leadership choose to pursue that type of retaliation (Petras 2002). The likely initial ambiguity behind the cyber actor's identity combined with the potential restoration of the satellite systems introduces additional obstacles to retaliation, however (McClure 2012).

Domestic Politics and Emerging Technologies

As Karbo (2015) notes, an emerging trend focusing on the impact of domestic factors on foreign policy has become prevalent in social science research. Recent survey experiments demonstrate that citizens in both democracies and autocracies care about international status concerns and empty commitments (Powers and Renshon 2020, Li and Chen 2021). Audience costs can also prevent opponents from initiating disputes as leaders fear domestic criticism, especially in democracies (Carter 2017, Crisman-Cox and Gibilisco 2018). Regarding direct military action, analyses of the Vietnam, Iraq, and Afghanistan Wars highlight the importance of casualty rates and financial concerns on public approval of the conflict (Mueller 1985, Gartner and Segura 1998, Gartner 2008, John and Davies 2019). Public approval, intertwined with embedded risk orientations, likely acts as the source of presidential decision-making on armed conflicts (Macdonald and Schneider 2017).

Public reactions to novel technologies, including drones, precision munitions, and hypothetical cyberattacks, are the target of several recent experimental surveys by political scientists. Walsh and Schulzke (2015) show many Americans are more likely to support drone strikes if they are effective at preventing loss of life in a warzone. Likewise, precision weapons create an expectation of avoiding collateral deaths in drone strikes leading Americans to further favor strikes that prevent civilian casualties in addition to American ones (Walsh 2015). Adding additional context to their previous studies, Macdonald and Walsh (2021) suggest situational factors may determine the choice of weapon used in a conflict. In their experiment, the authors varied circumstantial elements, such as weather, and found that public support did not differentiate between the use of ground troops or drones when the justification for choosing one weapon over another was explicitly stated. In the legal realm, Kreps and Wallace (2016) find that

legal critiques of drone strikes by international organizations (IOs) and non-governmental organizations (NGOs) are valuable in limiting domestic support for drone strikes, but effectiveness critiques are not.

Within the literature, there is a clear gap in considering space as a warfighting domain in the minds of the public. Would the U.S. public react similarly in a space-based conflict compared to a ground-based one? If so, what variables would determine support for retaliatory measures by the U.S.? These questions guided our research and acted as the foundation for our large-N survey.

Research Design

In the fall of 2023, we fielded our study on a sample of U.S. respondents recruited by Lucid.[4] Lucid used demographic quotas on age, gender, ethnicity, and region to ensure we had access to a broad and representative cross-section of the public. Of the 3,725 individuals who responded, 2,495 (approx. 66 percent) passed our pre-treatment attention checks.[5] All respondents read a common introduction:

> In the following set of questions, we will ask you about three closely-related, hypothetical scenarios that the United States could face in the future. While they are hypothetical, we have tried to describe them in ways that might closely resemble a real future event. Please read each scenario closely and then indicate your support for the measures described in the questions that follow.

[4] Coppock and McClellan 2019 show that survey experiments fielded on the Lucid platform return similar results to benchmark national samples. Because of rising inattention among respondents on the platform (Arnow et al 2022), we used two pretreatment attention checks in the survey to screen out inattentive respondents (Berinsky et al. 2021). The first asked respondents to select their favorite color, but the question included additional instructions for the respondent to select the "red" response option to show that they are paying attention. The second asked respondents to agree or disagree that "two is greater than one.". We code those who did not agree with that expression as inattentive. We present results for those that passed both pre-treatment attention checks. Our results are similar if we include inattentive respondents, but treatment effects are attenuated somewhat in magnitude. See the appendix for more details.

[5] Demographic breakdown is in the appendix.

We then generated three scenarios in which China, a potential adversary of the United States, attacks communications infrastructure in the United States. We varied the scenario in three main ways. First, we varied the location of the attack. Respondents learn that the attack was either against a U.S. communications satellite or against a communications ground relay station. Second, we varied the mode of the attack. Respondents learned that it was either a cyber attack or a kinetic attack with physical explosives. And third, we varied how long the impact of the attack would be felt. Respondents variously learned that the interruptions from the attack lasted a few days, a few weeks, or a few years. In addition to these three main treatment arms, some respondents assigned to the kinetic/ground attack scenarios also learned that a number of U.S. military personnel died in the attacks. We use the effect of these deaths on support to retaliation as a benchmark against which to gauge the magnitude of the effects that we observe in the other arms of the experiment.

After reading about the attack, we asked respondents to report their level of support for four different kinds of retaliatory measures: breaking off diplomatic ties with China, sanctions against China's economy, cyber attacks against China's communications infrastructure, and kinetic attacks against China's communication infrastructure. Responses were on a five-point Likert-style scale from "strongly oppose" to "strongly support" with neither option in the middle. For ease of exposition, we dichotomize this scale. We code those reporting any level of support as 100 and all other responses as zero. Results are qualitatively similar if we use the raw scale.

Table 1. Survey Treatment Conditions

Fixed: Aggressor and Victim	Varied: Mode of attack	Varied: Domain of conflict	Varied: Repair time
China attacks on U.S. communications infrastructure.	Kinetic	Ground relay stations (within ground, deaths: 0, 5, 15)	Quick (several days or weeks)
	Cyber	Satellites in orbit	Long (several months or years)

Research Design Motivation

China has emerged as a major challenger and is a potential adversary to the United States. With the U.S. communications infrastructure heavily reliant on satellite and ground relays, these objects represent likely targets for an adversary seeking to disrupt U.S. government operations. In our scenario, China acts as the aggressor targeting U.S. relays or satellites in the opening move of a conflict. In such a conflict, China could choose to strike a ground-based relay in the Pacific or a telecommunications satellite in orbit and could do so using either cyber or kinetic weapons. Varying the type of weapons used is important since this has been shown to have different effects on public opinion (Macdonald and Walsh 2021). We vary the costs of the attack in two ways. First, we vary how long the infrastructure is out of commission. A relay could likely be repaired in a relatively short amount of time, but in space, access is much more difficult, prolonging the time needed to restore the asset's capabilities. If a replacement is needed, government satellites take at least three years to develop and launch on average (Deifel et al. 2020). However, if a simple repair is needed on either space or ground assets, a timeline of weeks to months is reasonable. Evidence from previous literature shows that the prolonged

effects of attacks on the U.S. can directly affect support for retaliation (Leal and Musgrave 2022, Shandler and Gomez 2022, Shandler et al. 2023).

Second, we vary the cost of the attack by introducing casualties among U.S. military personnel to scenarios that included kinetic attacks on ground relays. In space, all satellites are operated remotely, removing the possibility of human deaths. On the ground, while cyber attacks *can* cause personnel deaths, it is historically unlikely. In contrast, a kinetic attack on a ground relay station manned by U.S. military personnel and causing casualties is more likely. For each ground-kinetic scenario, there were three fatality possibilities including zero, five, or fifteen military personnel deaths. Shandler et al. (2021) show that the lethality of an attack can increase appetites for stronger responses.

Results

We estimate treatment effects and marginal means using OLS. We regress support for each form of retaliation on indicators of treatment and a battery of pre-treatment control variables (gender, age, education, and expressed support for a U.S. military response to an invasion of Taiwan by China).[6] To facilitate unbiased comparisons between our space and ground conditions, we restrict our attention to this first set of analyses to scenarios in which no U.S. personnel died.[7] We use this model to estimate marginal means for each of the treatment conditions and present the results in Figure 1. The form of retaliation represented in each row is indicated with the label on the right. The severity of the retaliation is roughly ordered from least severe (new sanctions) to most severe (kinetic retaliation). The contrast in question (domain,

[6] We include these controls to maximize efficiency (Clifford et al 2021, Gerber and Green 2012), but our results are similar without them.

[7] Recall that in our space scenarios, no U.S. personnel ever die while in our ground scenarios, we randomly assign casualties to be either zero, five, or fifteen. Our initial analyses only include responses from the ground scenario for those assigned to the zero casualties condition.

method, or duration) is indicated by the column labels at the top. We report the average treatment effect across the contrast in question and the associated p-value in the text labels at the bottom of each subplot.

We begin by considering our main question of interest: whether respondents conditioned their support for retaliation on whether the attack took place in space or not. The leftmost column of Figure 1 plots estimates of support in the space and ground conditions averaging over the other treatment conditions for each of the dependent variables. For everything from new sanctions to kinetic retaliation, the public was indifferent to the domain of the attack. Whether the attack was in space or on the ground, there is broad support for both new sanctions and breaking diplomatic ties. Similarly, while absolute levels of support for more significant forms of retaliation (cyber and kinetic) are lower, they do not depend on whether the respondent learned that the attack was against assets in space or not. We take this as evidence that the public does not view attacks against space-based targets as qualitatively different from attacks against ground-based targets. We see a similar pattern of results when we examine the effect of the duration of the outage (middle column of Figure 1).

The story changes somewhat when we examine kinetic vs. cyber attacks (right column of Figure 1). The public appears to view kinetic attacks as qualitatively different from cyber attacks. While support for sanctions and breaking diplomatic ties is similar across scenarios in which kinetic and cyber attacks are employed, support for other forms of retaliation is higher in the case of kinetic attacks. The public is marginally more supportive of launching cyber attacks (ATE: 4.5 percentage points, $p < .000$) and significantly more supportive of kinetic retaliation in the case of a kinetic attack (ATE: 9 percentage points, $p < .000$).

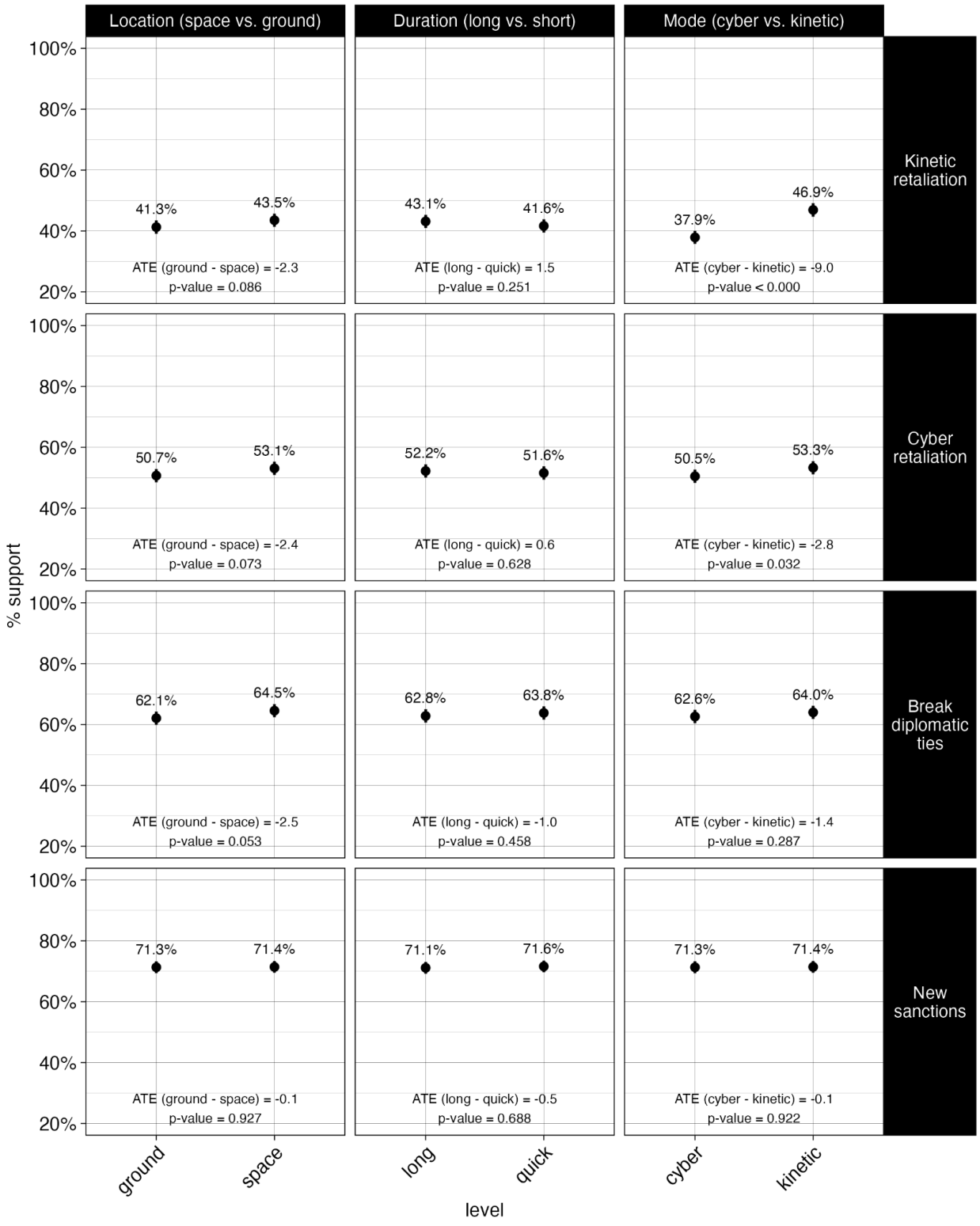

Figure 1. *Marginal mean support for retaliation against attacks by domain, duration, and mode.*

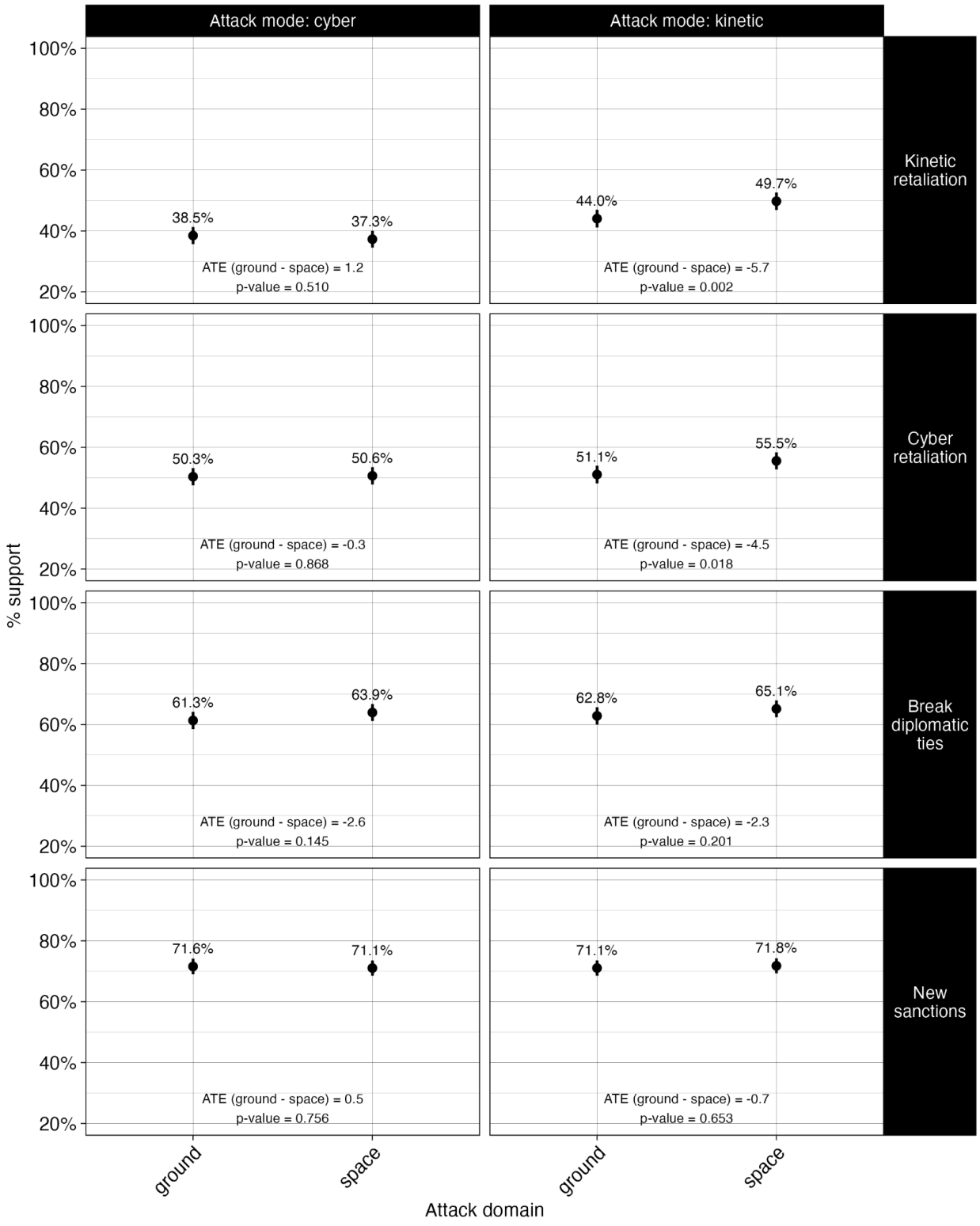

Figure 2. *Marginal mean support for retaliation by domain (space vs. ground) and mode of attack (cyber vs. kinetic).*

While the public is not sensitive to the domain of the attack, they do appear more likely to view kinetic attacks as warranting significant retaliation. By averaging over the other treatments, we may be obscuring differential effects across, for example, the domain of conflict. To investigate this, we produce estimates of marginal mean support for each form of retaliation for each combination of attack mode (cyber and kinetic) and conflict domain (space and ground). We plot these estimates in Figure 2. These results, again, show little evidence that the public distinguishes between space and ground attacks even when we account for differences in the mode of attack. The one exception is that respondents appear more willing to endorse kinetic responses to kinetic attacks on space-based assets than to identical attacks on ground-based assets (ATE: 5.7 percentage points, $p = .018$)).

Thus far, we have seen that the public does not generally distinguish between attacks on space-based and ground-based assets. We do, however, find evidence that the mode of attack is important to the public. While we took pains to construct scenarios that are in the realm of plausibility, none of the scenarios that we used have actually occurred in the real world, so it is hard to know just what the real-world significance of these effects might be. To gain some leverage on this question, we included treatment conditions in our ground/kinetic attack versions of the scenario that allow us to benchmark our findings against the well-studied effect of the death of U.S. military personnel. We plot the effect of these deaths in Figure 3. These results show that support for retaliation monotonically increases in the number of U.S. personnel deaths for all forms of retaliation. The most dramatic effect, however, is seen across personnel deaths in support for kinetic retaliation. Support is about 12 percentage points higher ($p < .000$) in the 15 deaths condition than in the zero deaths condition. This suggests that, in terms of its effect on public support for kinetic retaliation, moving from a scenario in which China has attacked U.S.

communications infrastructure using kinetically to a scenario in which they launch a cyber attack on the same assets has approximately the same effect as moving from a scenario in which 15 U.S. personnel are killed to one in which no personnel are killed, all else equal. These results are important because it suggests that our respondents were reacting to our scenarios in a manner consistent with the findings of past research and long-standing theories of the domestic politics of international conflict.

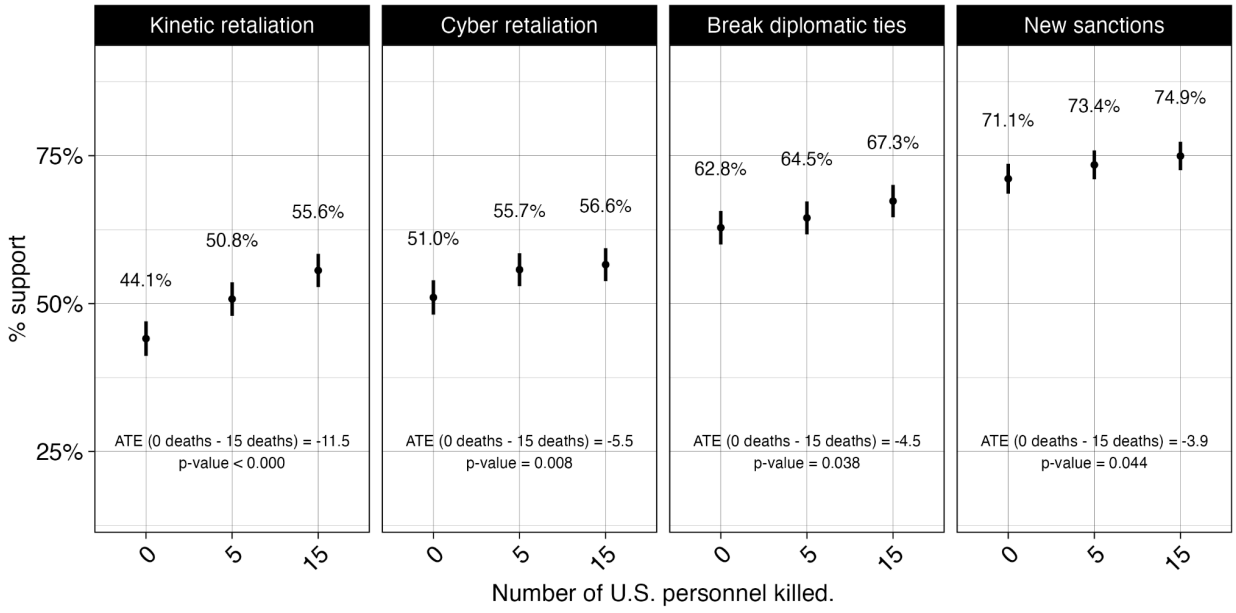

Figure 3. *Marginal mean support for retaliation across the number of U.S. personnel killed in the kinetic/ground scenarios.*

Conclusion

Using a survey experiment fielded in the United States, we show that the public does not condition their support for a wide array of retaliatory responses to foreign aggression on the domain of the attack. While the absolute level of support for measures up to kinetic responses varied in absolute terms, it did not generally depend on whether the attack was against

space-based or ground-based assets. In contrast, we showed the public does distinguish between cyber attacks and kinetic attacks, being less likely to support retaliation of various kinds in the case of the former. Likewise, we showed that the public is more willing to support retaliation of all kinds when kinetic attacks against ground-based assets result in the deaths of U.S. military personnel. These contrasting results are consistent with past research in this area and bolster our confidence in the null effect we found against space-based assets.

When analysts contrast space and ground-based conflicts, they are often comparing events that are likely to differ on a host of dimensions. We designed our experiment to carefully isolate the effects of location (space vs. ground) from other dimensions of foreign aggression (the mode of attack and its consequences). Doing so allowed us to isolate a "pure" space effect when all other factors are equal. Our findings suggest that, at least when it comes to attacks against space-based communications infrastructure, the theories we rely on to understand public reactions to foreign aggression and the responses of leaders are likely to serve analysts well. To the extent that scholars need to develop different tools to understand the domestic politics of conflict in emerging domains, it is likely to be that of cyber. In our studies, demands for retaliation were more muted in these settings. Others have written extensively on this issue, but, in our view, the implications for theories of domestic politics and escalation here remain unclear. Leaders may feel less *compelled* to respond to such attacks, dampening escalation dynamics. At the same time, anticipating fewer demands among foreign publics for retaliation might make cyber conflict more appealing to aggressors. This increased appeal might make the use of cyber warfare tools more frequent since leaders may feel less constrained, making escalation more likely. To make progress on these questions, scholars might employ experiments like ours on leaders and policy elites in an effort to decompose these cross-cutting effects.

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