Costly Signals in Space: Increasing Credibility via Strategic Disclosure

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Strategic disclosure of space programs can enhance the credibility of U.S. deterrence.

As the space domain has become more significant—militarily and otherwise—over the past decade, there have been recurrent calls to reduce the secrecy surrounding many of the systems currently being employed by the United States and others. This push can be attributed to several factors: the recognized tendency to overclassify space systems to begin with, the increasing need to work with commercial space companies, cooperation with partners and allies, and the need to make a case to the public that greater focus—and a new military service—on space is necessary.

These efforts have had some results, at least on paper. In early 2024, the Department of Defense approved a new classification policy that discourages applying the label of "Special Access Program."[1] Several months later, some space electronic warfare programs were reportedly declassified as a result, allowing the United States to share more with international partners, if not with the public.[2] However, aside from these spotty reports—that notably do not include details about which programs were declassified and what they are—there is little indication that much more information is on the way, publicly, about what capabilities the United States and its allies and partners possess in the space domain and what they are intended to achieve.

Arguments in favor of declassification are easily countered by those who argue that strict secrecy is necessary to preserve freedom of maneuver in space and not give an advantage to potential adversaries who may then be able to develop counter capabilities. In this sense, not disclosing exactly what the United States can do is a form of deterrence that creates uncertainty in the mind of a potential adversary. However, too much uncertainty could be counterproductive if it undermines a state's credibility so much that a target state does not believe a sender state has a capability or is willing to use it.

This paper argues that strategic disclosure and declassification of space programs can improve the US's deterrent abilities in the space domain by enhancing the credibility of deterrent threats. The primary mechanism through which this may be achieved is through the imposition of costly signals, namely strategic disclosure and audience costs. In the first case, strategic disclosure, the costly signal is that of declassification of space capabilities. Not only does this come at a significant bureaucratic and organizational cost, but it also allows an adversary to build and deploy countermeasures. This puts an expiration date on the capability which can increase the desire to use it prior to that point. Secondly, audience costs are generated when a leader is punished domestically for not following through on a threat. By making public

more aspects of US space systems and their potential effects, the US can increase public knowledge of the importance of the space domain and the resulting threats to the US, public knowledge and awareness is increased concurrently with the public's ability to impose an audience cost if necessary.

This paper contributes to several bodies of literature. First is the work that is being done to take established principles and theories of international relations and apply them to the space domain.[3] Uniquely, I identify a new kind of costly signal, strategic disclosure, and consider its cost imposition. Second, the paper contributes to the ongoing debates over declassification by providing a strategic argument for declassification that goes beyond simply increasing public knowledge or the ability of partners and allies to work with the United States. Finally, the paper contributes to the ongoing discussions of space deterrence—what it is, how it differs from traditional deterrence, and what unique qualities may contribute to how it operates most successfully.

I begin first by briefly describing the challenge of space deterrence before turning to a short discussion of costly signals and audience cost theory. It is not my intent here to fully review this deep body of literature, but merely to highlight the relevant ideas. I then discuss the main mechanisms through which audience costs may be utilized in the space domain to enhance the credibility of threats and thus enhance space deterrence.

SPACE DETERRENCE

Over the past two decades, a greater amount of attention has been given to the space domain and its potential to play host to kinetic conflict. Given the unique conditions of the domain, in particular the potential destructiveness of space debris, lack of gravity, and harsh operating conditions, kinetic conflict in space has the potential to significantly disrupt the projection of military power and the global economy.[4] The result has been greater attention paid to how to discourage or deter potentially bad or unwanted behaviors in space. However, because of both the lack of attention given to the domain and the lack of experience in deterring bad actors and bad acts, there is still confusion in both the academic literature and government policy over what is actually meant by space deterrence. Is it using space capabilities and/or the space domain to deter terrestrial behavior? Is it deterring a single actor in the space domain? Or deterring any hostile action or behavior in the space domain? This confusion is only reinforced by a 2023 Rand report which accurately notes that "there is no broadly agreed-on framework in the US and allied governments or the wider analytic community on the nature and requirements of deterrence in space operations."[5]

Unfortunately, refining the definition of space deterrence further is not within the scope of this present project. As such, I take space deterrence to be deterring hostile actions (by any actor) in the space domain against space assets. Further, as it is unclear at this time whether the US government would respond to an attack on US-based commercial space assets, the paper focuses only on US government space assets. Like hostile actions in terrestrial domains, these actions can vary. They could be non-kinetic in the form of electronic weapons or cyber attacks or kinetic anti-satellite weapons. They could also be temporary attacks to spoof or jam a satellite that have a definable period, or they could be permanent attacks that destroy or permanently disable space assets. Some analysts also include attacks on ground-based space infrastructure under the heading of "space attacks," but for our purposes here, I focus only on space-based attacks.[6]

Considerations of space deterrence have built on the traditional deterrence literature stemming from nuclear weapons. Thus, the basic underlying premise remains the same: how to convince an adversary that the costs of undertaking something are greater than the benefits they might receive. However, there are significant differences between nuclear or even cyber deterrence and space deterrence that make space deterrence arguably more difficult.

First, actions taken in support of space deterrence, unlike nuclear deterrence, may often be invisible or be difficult to detect. Though cyber weapons deployed in defense of space networks and systems may be one obvious example, on-orbit defensive systems may also go unobserved and unnoticed unless demonstrated. Second, space systems are quite vulnerable compared to nuclear weapons. Satellites, even if an actor does not know their exact capability, are easily tracked from Earth and generally travel in predictable orbits. Third, despite this level of predictability, there is difficulty in attribution in space as satellites that go offline may be victim or any number of things *other* than a kinetic attack (i.e., micrometeoroid/debris strike, internal system issues, spoofing, electromagnetic interference, etc.). Adding to this confusion is the ability of attacks in space to be reversible. If states cannot quickly and easily connect the dots and correctly attribute attacks (or non-attacks) on their space systems, the ability to demonstrate increased costs to an adversary is significantly reduced.

Reversibility of an attack contributes to a fourth difference—differences in attack threshold. While the threshold of what constitutes an attack in nuclear deterrence is quite clear, what constitutes an attack or even an *unacceptable* attack worthy of retaliation is quite different in space. Reversibility is one factor in this but so is the wide variety of satellites and space systems, both government and commercially owned. For instance, a reversible attack on a government-owned remote sensing satellite may not meet a threshold that denotes a deterrence failure whereas a reversible attack on a government-owned nuclear command and control satellite might. Along a similar line, does an irreversible attack on a commercial satellite owned by a US company represent an attack on the United States to which the US government must respond? While the absence to date of open conflict in space has contributed to this uncertainty, there is still likely to be a wide variety of attack thresholds during a conflict depending on its course.

Fifth, there are significant issues of credibility in play in terms of attacks in space and elsewhere. As Forrest Morgan notes, threatening an adversary's satellites, particularly an adversary that has fewer satellites or less capable satellites than the United States, might only invite a tit-for-tat that harms the US more given the heavy reliance on space-based systems for

power projection. "Threats of punishment in the terrestrial domain may lack credibility in crises and at lower levels of limited war and would likely be irrelevant at higher levels of war, when heavy terrestrial attacks are already under way."[7]

Sixth, there are more actors with the capability to undertake attacks in the space domain than in nuclear, making space far more akin to the cyber domain in this respect. While only a few states have indigenous launch capability, more states and even non-state actors, have cyber capabilities that can target space networks. Further, both state and non-state actors can target ground stations that are necessary for space systems to work including launch sites and ground terminals. Commercial actors may even have attack capabilities in the coming years further complicating efforts at space deterrence. Despite calls for tailored deterrence approaches aimed at China or Russia, the sheer number of actors with a potential to attack in or through space runs the risk of oversimplifying and ignoring other potential adversaries.

Finally, and perhaps most importantly, traditional nuclear deterrence aims to prevent the use of a single type of weapon. Space deterrence aims to deter a wide range of bad behaviors that have the intent to damage space capabilities. Notably, this includes attacks on ground infrastructure that supports space capabilities, i.e., ground stations and operations centers, including cyber attacks. As noted previously, space deterrence, then, seeks to dissuade an adversary from taking a very wide range of actions in space ranging anywhere from something minor like close proximity operations or Earth-based attacks on space systems (kinetic or cyber) to the much more dangerous kinetic anti-satellite attacks, attacks on ground stations, or even the use of space to ground weapons. To do so, the United States specifically uses threats of in-space and on Earth retaliation which, as noted above, can significantly impair the credibility of deterrent threats. Compared to nuclear deterrence then, space deterrence must consider a far greater range of bad behavior across a much larger number of potential adversaries, with a larger number of contextual factors to consider in determining its success.[8]

US policymakers and leaders have undertaken measures that are hallmarks of both deterrence by denial and deterrence by punishment strategies. In recent years the Department of Defense (DOD) has significantly increased the number of satellites it relies on in orbit (both government and commercial) thereby increasing the resiliency of space-based systems (deterrence by denial). In a 2024 speech, Deputy Secretary of Defense Kathleen Hicks directly connected this increasing resilience to deterrence, stating the US "is committed to preventing conflict through deterrence by making clear to our competitors that the costs of aggression would far outweigh any conceivable benefits."[9] Similarly, the head of the Space Development Agency argued that proliferation of satellites is the best defense the United States has in space and best way to increase resiliency.[10]

Unfortunately, beyond these scattered statements from US officials on elements of space deterrence, the US has communicated little to the world or its potential adversaries about how the US may respond given an attack on its space assets. Actions across the US government to increase resilience and redundancy of space systems aids a deterrence-by-denial strategy but official documents do not provide much more elaboration. The most recent US Space Defense Strategy from 2020 has four lines of effort including building military advantage, integrating military spacepower across the joint force, shaping the strategic environment, and cooperating

with allies, partners, and industry. The most specific statements in terms of deterrence are rather anodyne: "Deter adversary aggression against the space capabilities of the United States and its allies, partners, and commercial interests."[11] There may be additional language in classified documents or communicated along private channels, but this is yet another way in which the strict secrecy in which space activities is placed continues to frustrate those looking for clear messages.

In actions and statements such as these, the US *communicates* to potential adversaries the *capabilities* that they have, and the increased costs potential adversaries would face in attacking them but has done little to increase the *credibility* of those communications. This mirrors the focus on capabilities and communications and the lack of discussion of credibility in the limited literature on space deterrence. For instance, Morgan suggests a strategy that raises costs and reduces benefits for an adversary "by improving defenses, dispersing and concealing space capabilities, reducing US dependence on space by developing alternative capabilities, and demonstrating the ability to rapidly replenish whatever losses are sustained."[12] The 2023 Rand report distinguishes between three different space deterrence archetypes (denial dominant, mixed deterrence, and offense dominant) but argues that a more comprehensive approach, "one that seeks to regulate the use of force in space in the interest of stability; ostracizes states that violate agreed-on norms; and allows states to retain some capacity to punish space aggressors in multiple domains and to develop measures to enhance the defenses, resilience, and redundance of space systems," is most likely to succeed.[13] Dean Cheng and John Klein, thinking about space deterrence with respect to China, suggest that deterrence strategy be updated to include an element of dissuasion, the development of space debris removal capabilities, and the development of a space attribution framework.[14]

In this focus on capabilities and communication, credibility has been all but ignored. This is despite an acknowledgement in a 2021 Rand report on tailoring deterrence in space for China that "for credible assured retaliation to be an effective component of a deterrence strategy in space, a potential aggressor should have no doubt about the deterrer's ability to retaliate and its intention to do so."[15] Later in the report, the authors do suggest the US take visible actions (i.e., doctrine, training, and exercises) that could contribute to a threat's credibility, but again, little attention is given to this issue in the report's suggested strategy.[16] While most writings on space deterrence acknowledge the importance of credibility, few give any further attention as to how this might be achieved. Because credibility is so entwined with effective communication (capability and intention is what needs to be *credibly* communicated), its absence significantly hinders a holistic consideration of space deterrence.

Addressing credibility in space deterrence is perhaps even more important now, before open conflict in space has been experienced. Given that significant attacks on space assets (either kinetically or non-kinetically, temporarily or permanent in their effect) have yet to occur, there remains a question about state resolve and willingness to carry through on a threat which increases uncertainty in the mind of a target state. Is a state ready to risk, not just escalation, but significant damage to the space domain to respond? Should conflict break out in space and states have the opportunity to utilize and thus demonstrate capabilities, credibility will be easier to establish in light of past action. In the absence of such an opportunity, states must look for other ways to enhance the credibility of space deterrent threats.

COSTLY SIGNALING

Since the publication of James Fearon's seminal article in 1994, a large literature surrounding costly signals generally and audience costs specifically has developed. It is not my intention here to discuss in depth or critique this ever-increasing body of knowledge. Rather, I focus on the main elements of these theories and major findings that may have relevance to the space domain.

In his 1994 article, Fearon begins with a crisis where states have incentives to discover whether there is an outcome both prefer to use of force, but also an incentive to misrepresent their desires. He writes, "States resort to the risky and provocative actions that characterize crises (i.e., mobilization and deployment of troops and public warnings or threats about the use of force) because less-public diplomacy may not allow them credibly to reveal their own preferences concerning international interests or to learn those of other states."[17]

Because states have a disincentive to be honest in their crisis communications, Fearon considers potential costly signals that states could send to reinforce the credibility of their threat. Sunk costs include "financial and organizational costs of mobilizing and deploying troops and also simple impatience ('time preferences') on the part of state leaders," particularly when this burden is so high that states cannot maintain it for long.[18] Audience costs, on the other hand, are the costs imposed by a domestic audience on a leader who does not follow through on a threat. In a 1997 article, Fearon also classifies audience costs as part of a larger category he calls "tying hands," which "means taking an action that increases the cost of backing down if the would-be challenger actually challenges."[19]

Between these two pieces, Fearon argues that audience costs may be the most significant cost that leaders can adopt. He concludes that, while both are costly signals, states do better on average when audience costs are leveraged. Further, he theorizes that tying hands may be more likely to succeed in crisis scenarios as compared to broader grand strategy type issues where sunk costs (i.e., alliances or military exercises) may be more readily employed.[20] In sum, the major proposition drawn from Fearon's work is that leaders, by making a public threat that they can then be held accountable for, increase the credibility of a threat.

In the literature that developed since Fearon's two pieces, scholars have further examined the logic and evidence of costly signals, focusing not just on audience costs but also features that condition the reception of costly signals such as leader reputation and credibility.[21] Unfortunately, the literature on costly signals versus cheap talk is not as advanced as the body of work that has since developed around audience costs. Tingley and Walter suggest that this may be due to methodological difficulties in both qualitative and quantitative analyses of cheap talk. For example, they argue that large N analyses may find it difficult to control for initial beliefs in interstate interactions which help to condition cheap talk.[22] Further, this emphasis on audience costs might also be a result of what Joseph claims is a tendency among scholars to believe that "the incentive to misrepresent intentions [among states] was overwhelming" and so illustrate a reticence to more fully test cheap talk versus costly signals.[23] Also telling, however, is that many of the studies finding some effectiveness of cheap talk to change state behavior is based on microbehavioral foundations of individuals in laboratory experiments rather than

testing such theories on real world data.[24]

That being said, some studies have suggested that cheap talk may be effective. For example, utilizing formal modeling, Joseph argues that cheap talk via diplomacy may be effective if accompanied with some information. However, the inclusion of information to increase the effectiveness of diplomacy may indeed constitute a cost, albeit a smaller one than the kinds that Fearon proposes. Along a similar line, Tingley and Walter argue that cheap talk may be effective in situations where states have little information about one another. Building on formal modeling once again and illustrated through two case studies, Ramsay argues that cheap talk can be effective if countries are willing to negotiate and communicate that message.[25]

Turning to audience costs, scholars have elaborated on the various underlying mechanisms at play when audience costs are invoked. In a traditional view, electorates punish leaders who do not follow through primarily via electoral mechanisms. Thus, a sub-argument inherent in the audience cost literature is that democracies may be better positioned to impose audience costs because elections can be used as a means of punishment. However, the question remains exactly *what* an electorate is punishing and *why*. Fearon argues that audience costs are found when an electorate punishes a leader for not following through because they are concerned about the state's international reputation and prestige, but other mechanisms have also been proposed.

For example, Kertzer and Bruger argue that it is not just about punishing a leader for not following through (what they call an inconsistency effect) but punishing a leader for making a threat in the first place via a belligerence cost.[26] To this, Nomikos and Sambanis argue for the idea of an incompetence cost in which an audience punishes a leader for not achieving an audience's preferred outcome.[27] Further, some of these scholars argue that some domestic political factors might also condition the extent to which individuals would punish a leader. Kertzer and Bruger argue that foreign policy hawks and doves might punish leaders for different reasons: hawks might punish for inconsistency whereas doves might punish for belligerence.[28] As a whole, these lines of inquiry help us to clarify underlying motivations for punishment as each of these different costs represents a different kind of reason for an electorate to punish a leader for what is said and done (or not done) during a crisis.

Regardless of underlying mechanism, a key assumption of the audience cost literature is that audiences *know* of the threat and know *enough* to judge whether the leader is inconsistent, belligerent, or incompetent. This is particularly important in foreign policy crises as the situations are likely to be more complicated. Slantchev supports this arguing that audience costs can only be credibly imposed when audiences can not only credibly sanction the leader but can learn about contrary behaviors.[29] Similarly, Gibler and Hutchison argue that issue salience is also important in a democracy as citizens are unlikely to be presented with foreign policy crises that are existential in nature.[30] The importance of knowledge and salience are both particularly important as we consider audience costs for space because public awareness of space issues is rather low. Further, very few voters (at least in the US) consider space an important enough issue that a political candidate's position on it would potentially change their vote.

Analyses testing audience cost theory (and its variants) have, perhaps unsurprisingly, yielded mixed results. Beginning with tests in the aggregate, early analyses using data such as the Correlates of War suggested significant support for Fearon's model.[31] These findings have continued to hold even as countries like the United States have experienced far greater levels of

political polarization which might suggest electorates would be unwilling to punish a leader of the same political persuasion.[32] One key finding of these analyses is that even small audience costs can help stabilize crises as well as have "a deterrent effect on dispute initiation."[33]

Support has also been found at the individual level. The first experimental, survey-based test of audience costs by Tomz in 2007 was largely supportive of Fearon's theory. Of note, and of relevance to the debate over specific mechanisms at work, Tomz found that individuals believed that inconsistency of a leader's words and actions hurt a country's reputation leading to the individual punishing the leader via reduced support and approval ratings.[34] Tomz's survey, however, highlights a significant critique throughout the audience cost literature revolving around the appropriate methodology through which to test the hypotheses. The survey asked respondents whether they approved or disapproved of the way in which a leader handled a particular (fictional) situation. Both Chiozza and Croco, Hamner, and McDonald suggest that this is an inappropriate measure of audience costs.[35] More specifically, both of these studies suggest that situational approval is not the same as general approval. Chiozza's 2017 study shows this in action: a decline in approval ratings is not the same kind of punishment as voting a leader out of office. As a result, Chiozza finds that audience costs vary throughout an election cycle—immediately following an election, audience costs are lower and then increase right before an election.[36] While this says something about the ability of an electorate to impose audience costs, it also suggests that democracies may be more likely to signal resolve via audience costs immediately following an election so as to short circuit the ability of an electorate to hold leadership accountable.

In examining research that discounts the idea of audience costs, two general ideas stand out. First, the methodological issues highlighted by the appropriate means through which to measure the cost noted above continue to be significant.[37] Much of this critique has to do with specifying the appropriate mechanism at work in audience cost theory as discussed above. To this, another methodological concern is argued by Moon and Souva, specifically that audience costs only pertain to situations in which there is information asymmetry, not cases in which there is a credible commitment problem.[38] As a result, they contend that the cases to which audience costs pertains is much smaller than that that has been previously studied. Relatedly, Schultz, argues that countries can self-select into a situation in which audience costs can be generated. This also means that countries have the option to select out of these situations as well.[39] As Schultz writes, "So does the mechanism fail because leaders cannot tie their hands in this way [audience costs] or because they can but choose not to for strategic reasons?"[40]

In addition to the selection critique, Schultz also argues that little qualitative and historical evidence had been found (at least to that point) that supported the quantitative findings that had emerged thus far in the field. Following this 2001 article, some scholars, notably Snyder and Borghard and Trachtenberg, found little evidence for audience costs in their qualitative study.[41] Levy, however, argues that both Snyder and Borghard and Trachtenberg go too far in minimizing audience costs while praising the use of process tracing to demonstrate plausible alternative causal mechanisms.[42] In response to this challenge, later studies have utilized qualitative evidence in supporting the audience cost theory thus undercutting this particular critique.[43]

A second major critique of audience costs is aimed at preferences for going public in a crisis and thus imposing audience costs and staying private so as either not to impose audience costs or to be able to bargain with a freer hand. In examining American presidents in particular, Baum suggests that when security interests are modest, presidents are less likely to go public, preferring to stay private so as not to increase the cost of failure.[44] While Baum finds evidence in post-World War II crisis history for his hypotheses, Takei, in examining individual public opinion, tests the credibility of public versus private threats finding that both are effective but public threats more so.[45]

It is not surprising to find mixed results in any given literature, especially when the differences arise from methodological differences. But there are tantalizing hints in this body of work that strongly suggest the ability of audience costs to increase the credibility of threats in salient crises, particularly in democracies. Further, some of the results also suggest that audience costs can be helpful in increasing the credibility of deterrent threats.[46] At face value, then, it appears that finding a way to impose audience costs, and costly signals more generally, may indeed be a viable mechanism through which to support space deterrence.

COSTLY SIGNALS IN SPACE

Given the difficulties noted previously about applying theories of deterrence in the space domain, sending costly signals may be one way of increasing credibility of threats. To begin, recall that space deterrence is intended to prevent a wide range of bad actions in space. We thus consider a variant of Fearon's starting question: what kinds of costly signals can the United States (or another state even) send that increase the credibility of space deterrence? To answer this, we can consider two different time horizons: a more general state of deterrence and a period of crisis bargaining. Fearon proposes two potential costly signals, sunk costs or tying hands via audience costs and suggests that in considerations of grand strategy, both tying hands and sunk cost mechanisms are often at work whereas in crisis, audience costs are more likely. Table 1 summarizes Fearon's costly signals (applying to non-space domains), and the costly signals proposed here for the space domain.[47]

Table 1: Deterrence Periods and Costly Signals in Space and on Earth

	General Deterrence (Grand Strategy)	**Crisis Deterrence**
Conventional, Non-Space Domains	Tying hands via reputational costs; sunk costs	Tying hands via audience costs
Space Domain	Sunk costs via strategic disclosure	Tying hands via strategic disclosure which supports the imposition of audience costs

Strategic Revelation

It is no secret that many military and national security related space activities are considered classified in the United States and elsewhere. While the United States has attempted to become more transparent over the past several years, there is still a significant amount of

knowledge about what the United States does in space that is kept from the public eye. Aaron Bateman points out that as space capabilities were more fully integrated into military systems in the 1970s and as they became the mechanism for verifying arms control treaties, secrecy was prized even more.[48] More recently, arguments concerning space secrecy have centered on seeing advantages granted by space capabilities as potentially temporary. In other words, if the United States (or any country) were to reveal what space-based capabilities they had, other countries might be able to develop means of countering them.

Despite the desire among many to keep space capabilities a secret, there has been a greater push in recent years to declassify some programs. In 2023, Chief of Space Operations, General Chance Saltzman acknowledged the need for declassification as well as the immense complexity of doing so. However, he also saw progress in that effort given that he has been able to talk openly about Chinese counterspace capabilities and potentially dangerous Chinese behavior in space.[49] This point is instructive—although Gen Saltzman and other space leaders can talk more openly about the activities of other countries in space, there has not been greater discussion of what the United States and its allies and partners are doing in space. In early 2024, the DOD rewrote its policy on classification, allowing each of the services, the Space Force included, to determine classification levels of their respective programs.[50] Since then, however, there have been no further public announcements concerning space capabilities or classification from either the DOD or the Space Force.

Two questions must be considered in thinking about how strategic revelation enhances credibility and thus deterrence: how it generates cost and what that cost is buying, i.e., how it increases credibility. If a target state is unsure whether a sender state is bluffing with cheap talk or is demonstrating its seriousness of purpose, disclosing capabilities is a costly signal that helps to reveal to the target state the sender's real intention, reducing the target's uncertainty about whether a sender state is serious or is bluffing.

There has been limited attention to capability revelation or strategic revelation in academic literature. Despite this, Evan Braden Montgomery writes that actions such as "capability demonstrations are likely to become increasingly relevant" as "states that want to reveal the value of their investments and reap the strategic benefits might need to emphasize demonstrations to reduce this uncertainty."[51] With respect to space, a recent Rand report summarizes that "A state might choose to disclose a new capability to dispel uncertainty about its abilities, inform assessments of the military balance, create new functional and geographic challenges for a competitor, and divert adversary attention and resources—all with the ultimate aim of deterring and weakening a potential challenger."[52] At the same time, however, the authors note the ability of a demonstration to create a misperception in the eyes of an adversary that might change the extent to which the capability serves as a deterrent. The report concludes that "the proposition that selective revelation of US space capabilities might promote greater space stability is generally valid but difficult to operationalize."[53]

Based on this work, there are several benefits of strategic disclosure: reduce ambiguity of threats and capabilities in order to enhance deterrence, bolster assurance, impose costs by creating new challenges for an adversary, divert adversary attention and resources, and even weaken a potential challenger.[54] This research argues that the cost that is imposed in revealing

capabilities is in reducing uncertainty about capabilities and communicating, but it does not speak to how and why a costly signal in the form of strategic revelation enhances credibility. At a time when there has been no historical record of conflict in space and there is substantial asymmetry in space capabilities between certain pairs of states, credibility of threats remains an outstanding question. How can a target state discern whether a sender state is bluffing?

States can use strategic revelation to enhance credibility because of the significant costs both internally and externally in revealing capabilities. In terms of internal cost, the most significant is in the bureaucratic effort that is required in the United States to declassify previously tightly guarded information. Though it might appear relatively easy for a president to declassify (on accident or purposefully) some bit of information, other leaders do not have it so easy. Speaking in December 2024, nearly a year after DOD's promulgation of a new declassification policy, the head of US Space Command, General Stephen Whiting said:

> There's just a lot of work to do when you're taking something from a very high classification level and pulling it down. Things like you've got to move all the information off of different networks onto other networks. And that is not trivial work. There is work ongoing to take our blue systems and run it through that process. But no blue system has gone through that process completely.[55]

Were the US or any other country to go to all the trouble of declassifying a space system or program with all the internal costs inherent in doing so, it would send a significant signal not just of capability but of the seriousness implicit in the threat, thereby reducing uncertainty about a state's resolve.

A second cost is an external one—giving the adversary knowledge of a capability and thus allowing them to create countermeasures. Strategic revelation may be even more important in a short-term crisis as the adversary state is unlikely to be able to develop and deploy useful countermeasures quickly. In the long term, however, this is quite possible. This is counter to the argument developed by Brendan Rittenhouse Green and Austin Long, who argue that signals of this sort are more effective in peacetime as crisis communication has the potential to lead to more instability, uncertainty, and noise.[56] Disclosing and revealing capabilities, particularly in crisis, further enhances the credibility of the threat as the threatening state has essentially put an expiration date on their capabilities thus encouraging them to stand firm and use the capability if need be. This argument for strategic revelation is very much in line with Fearon's argument, "[T]he greater the costs created by escalation for a leader, the more likely the leader is to be willing to go to war conditional on having escalated a dispute."[57] In this case, the leader has imposed the cost of declassifying systems thus tying their hands in a slightly different way. To be sure, such a demonstration would need to be done carefully with the appropriate communications so as not to create more problems than it would solve.

The possibility that an adversary state would develop countermeasures is significant, but it is mitigated by another characteristic of the space domain: the inability to hide. Try as they might, large satellites in orbit cannot be easily hidden—they are observable to amateur astronomers on the ground just as they are observable to adversaries. And though orbits can and do change, for the most part they are predictable. Given the increasing sophistication of observing satellites (that may or may not be equipped with antisatellite capabilities), it is safe to assume that an adversary, at minimum, knows how many satellites there are and generally

where. And in the case of highly capable states, they can most likely image them via ground-based observation systems or on orbit capabilities.[58] They (and we) may not know exactly how they work, but we have pretty good guesses. Publicly revealing a general capability, then, would not necessarily reduce a capability's effectiveness if sensitive to countermeasures, but would help instead increase the credibility of the threat.

A follow-on question is whether this is an example of sunk costs or tying hands. It could be seen as a form of tying hands in that disclosing sensitive capabilities essentially forces those capabilities to be used for fear of future countermeasures. On the other hand, it can also be seen as a sunk cost in the high cost the disclosing state pays without affecting the relative value of fighting. Fearon himself acknowledges that there are "few examples of the pure case" as many actions a state can take have features of both sunk costs and tying hands which are ideal types.[59] To a certain extent, it may not matter which category strategic disclosure falls into as long as it is a costly signal. However, *when* strategic disclosure is made, either in furtherance of general deterrence or crisis deterrence, may change categorization by the adversary. In general deterrence, disclosure better resembles a sunk cost whereas disclosing capabilities in a crisis may be perceived as tying hands.

Strategic disclosure as a sunk cost may be even more important for the space domain compared to terrestrial domains. Sunk costs involve costly mobilizations and/or deployments of troops and weapons systems that can help signal a country's intentions and the credibility of threats. Unfortunately, imposing sunk costs such as these is far more difficult in the space domain. Space systems typically take years of development and then may wait even longer to be launched into space. And although the United States has prioritized development of rapid launch capabilities, they have yet to come online and even when they do, will depend on hardware existing that can be launched.[60] Once launched, systems may take even longer to reach their desired orbit and longer still to be tested and declared operational.

In terrestrial domains, then, it is not that sunk costs cannot be or are not used in crises, but that the research has tended to show they are less effective in signaling credibility than tying hands. In space, it is not a matter of testing which is more effective but recognizing that it is incredibly difficult to sink costs *during a crisis* in the first place. Sinking costs in the form of additional space capabilities may have more potential when thinking long term about competition and even conflict in space, but in the event of a short-term crisis scenario, it will be all but impossible (at least now) to do.

Strategic revelation's "cost" as a signal comes from the effort and time that it takes to declassify internally as well as the external costs noted previously in publicizing capability. If a state is willing to "spend" on strategic revelation, it can reduce a potential adversary's uncertainty about whether a state will behave as it has threatened—its resolve—enhancing credibility and, ultimately, strengthening deterrence. Further, this is not the only way in which strategic revelation is a costly signal. Strategic revelation can be used with audience costs in such a way as the effects of each are reinforced to further increase a threat's credibility.

Audience Costs or "Tying Hands"

While strategically revealing capabilities may enhance credibility on its own, it also enables the imposition of audience costs. This is particularly important in the space domain, as public awareness and knowledge of space is relatively low in the United States. If there is low knowledge generally, any threat made in a crisis may be relatively low in cost and therefore impose fewer audience costs and convey lower credibility. Finding a way to increase audience costs for space not only increases the credibility of deterrent threats but prepares the ground so that when there is a crisis and a threat made, the public knows enough: audience costs are high and therefore a better signal of credibility.

Telling the public exactly what space capabilities the state possesses—declassification—is a costly signal that increases public knowledge and awareness, which in turn allows audience costs to be imposed in a crisis. Before audience costs can be imposed in space, however, the public must *know*—about the dangers faced in the space domain, the capabilities the state must confront, and the threat that is being made towards the adversary. This is very similar to the argument made by Evers, Fisher, and Schaaf that, "To be in a position to impose audience costs, Democrats and Republicans may need to have a certain level of political knowledge of their party's stance on foreign intervention, as well as the political ramifications of leaders reneging on military threats."[61]

The problem with imposing audience costs in space, however, is not just the fact that much of it remains classified but that the public knows and cares little about space. In 2018, the General Social Survey (GSS) reported that only about 25 percent of its respondents were very interested in space, compared to 44.6 percent who said they were moderately interested, and 29.7 percent who were not at all interested. In another question the GSS asks whether the United States spends too much, too little, or about right on space exploration (Figure 1). While the number of respondents reporting too much has been decreasing since 2002, it has ticked back up again with 28.1 percent saying too much, 47.1 percent saying about right, and 20.29 percent saying too little in the most recent year of data.

Figure 1: Does the US Spend Too Much, Too Little, or About Right on Space Exploration, 1973-2022 (GSS)
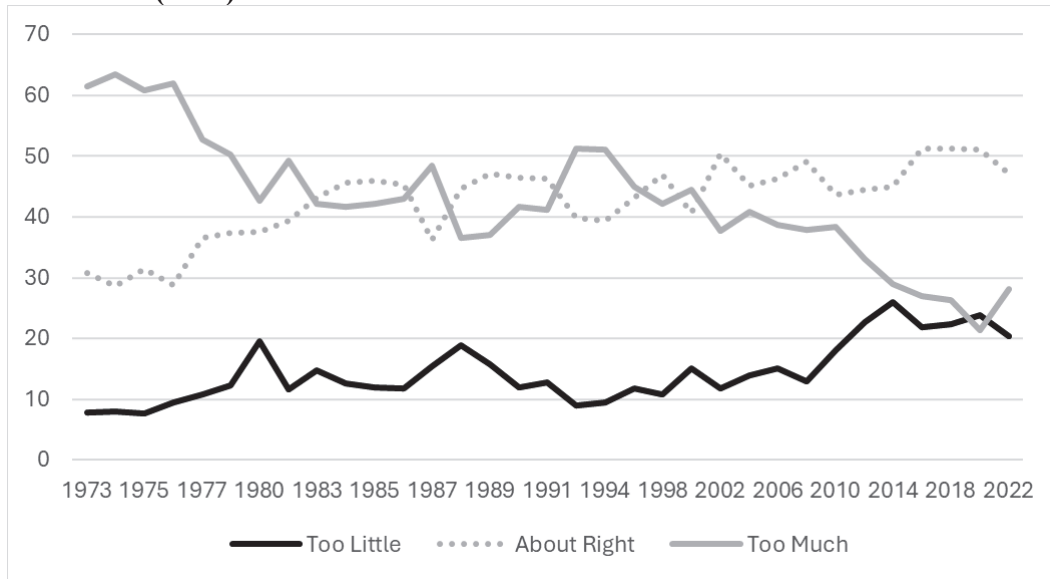
While recent public opinion polls show that the American public remains largely supportive of NASA, what they consider to be priorities is almost completely opposite of what NASA is focusing on. In a 2023 Pew poll, for example, sending humans to the Moon and Mars were the two lowest ranked activities while monitoring asteroids and climate change were ranked 1 and 2, respectively.[62] This contrasts sharply with NASA's efforts on the Artemis program, which takes up most of its budget and time. Similarly, reported engagement with "space-related activities" in the same poll is shockingly low. Only 47 percent of respondents said they engaged in at least one space activity (looking at telescope images, watching an astronomical event, watching a space launch, or visiting a planetarium or space museum). Further, interest appears to be *declining* in participating in things such as space tourism—in 2023, only 35 percent said they would be interested, down seven points since 2018.[63]

Admittedly, this data is restricted to amorphous ideas like "space exploration" and what NASA does. A counterargument might be that the public knows and cares more about military and national security space given how important it is. Unfortunately, there is little evidence that this is the case. Since Donald Trump announced his support for an independent space force in his first administration in 2018, the public has typically reacted with laughter and jokes. Headlines touted the new service's public relations problem, acknowledging not just the jokes being made about it, but low public awareness.[64] In the years since 2019 when the Space Force was established, little movement has been made. In 2024 testimony to Congress, one Space Force official acknowledged a "brand recognition" problem—in a DOD sponsored study, awareness of the Space Force among their target audience was a paltry 4 percent.[65]

The traditional audience cost literature tends to focus on specific cases where a threat is made publicly thereby allowing a leader's domestic audience to decide whether or not the

leader follows through, and if not, what the punishment should be. This model is most applicable in crisis deterrence situations. In general deterrence situations, on the other hand, disclosing capabilities sends two types of signals. The first is a signal to a leader's domestic audience of a potential threat and what the state could possibly do to confront it. This helps prepare the groundwork for the imposition of audience costs in crisis situations. A second signal is one that is indirectly sent to a target state because of the public disclosure to a domestic audience. In the case of space, a target state might not believe that a sender state will follow through on its threats or use its capabilities because they remain secret. But if a public audience knows of the possibility to confront or stop a threat, there may be greater public pressure to do so, even in the absence of a specific threat on the leader's part.

Though it might be possible to impose audience costs in a crisis by levying a public threat, the public must know enough about the seriousness of the situation, the threat, and whether the leader follows through or not. The data do not show that to be the case. Although it may be possible to impose audience costs in the moment, a much more feasible way of doing so is to think proactively and prepare the ground now, not just to increase the credibility of deterrent threats but to increase the credibility of threats in a crisis. While some of this could no doubt be done without reference to classified space systems, talking more openly about what distinct threats exist and what distinct capabilities the United States must use to confront them would likely draw far more attention than continuing to talk in generalities as has typically been done.

And while messaging to an adversary is important, according to Fearon, it is the messaging to domestic audiences that is more important. In other words, it doesn't necessarily matter what the adversary knows about a state's space capabilities (they probably know more than the public does in any case as discussed above); it is what the public knows about space, the crisis, and the public threat that imposes costs and therefore increases credibility. Further, Fearon argues that "observable measures of the balance of capabilities and balance of interests should be unrelated to the relative likelihood that one state or the other backs down in crises where both sides choose to escalate."[66] If an adversary state knows about a target state's capabilities, this is private information about what the target is capable of but not necessarily information about its *willingness* to use said assets.[67] In other words, adversaries do not necessarily care about the actual balance of power or capabilities, but the defender's willingness to use those capabilities as demonstrated through public statements.

It is almost inevitable that the United States will face a threat from potential adversaries in space. Already, it is engaged in attempts at deterring bad actions from potentially dangerous competitors in orbit. An effective strategy that both deters generally and can respond effectively in crisis will require domestic audience participation. This means not only demonstrating credibility through costly signals such as strategic revelation to opponents but also communicating those revelations to the *domestic public* to "prepare the battlefield" for the imposition of audience costs.

CONCLUSION

This paper has considered ways in which to enhance the credibility of space deterrence via the imposition of two costly signals, strategic revelation and audience costs, in two different deterrence contexts. I argue that in times of general deterrence of bad actions in space, sunk costs via strategic disclosure can enhance credibility. During times of crisis, strategic revelation may become a form of tying hands that contributes to a second costly signal generated via domestic audience costs.

While most states, the United States included, tend to be more reactive than proactive to foreign policy threats, it would behoove the US and others to consider the methods available to enhance deterrence generally and space deterrence specifically. Given the unique qualities of the space domain, some mechanisms of doing so are simply unavailable. Further, there is little recognition of how the lack of public awareness of space issues might impact crisis scenarios. Though the two costly signals considered here can be considered separately, ideally, they would be used together as disclosure of classified systems can help increase public awareness and knowledge thus further providing a foundation for potential audience costs in the future.

This article also contributes to the growing literature applying traditional international relations concepts to the space domain. While some concepts such as the security dilemma may be applied directly to space, others may not as readily be so. For example, the growing use of commercial space companies to provide military capabilities could be contributing to a unique version of the security dilemma, something I have termed elsewhere the commercial space security dilemma.[68] The unique environment of the space domain and its operational requirements suggest that in some cases, subtle adjustments to theory may be necessary. This is indeed the case with respect to costly signals if sunk costs cannot be applied. Further, study of the space domain may suggest new possibilities for terrestrial international relations, as this article does in the analysis of strategic revelation. Future research may build off the experimental survey research performed in the audience cost literature to examine whether increased knowledge of space capabilities and threats may better position individuals to assess crisis or deterrent threats as to whether leaders followed through or were inconsistent.

The challenge with much of the literature about security in the space domain is that without actual examples of conflict in space, it remains largely theoretical at this point. While we should not rush into changing that situation, considering the application of ideas such as those presented here may delay its onset, if not indefinitely, then for longer than it might have otherwise.   *S&D*

NOTES

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