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CAN CHINA TAKE TAIWAN?

WHY NO ONE REALLY KNOWS

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EXECUTIVE SUMMARY

Military analysts often use modeling to predict specific outcomes in war, including winners and losers, casualties, territorial gains or losses, and combat duration. But a potential U.S.-China war over Taiwan, likely also involving some American allies, poses analytical and policy challenges that make predicting outcomes especially difficult. In particular, the outcome of a Chinese maritime blockade of Taiwan scenario, in which a U.S.-led coalition aids Taiwan's military to break the blockade and keep the island polity economically viable, may be too close to call.

In this paper, a combination of simple military modeling and path-dependent scenario or campaign analysis is used to determine whether the outcome of a maritime blockade of Taiwan can be feasibly predicted. The methodology draws from the well-structured and clearly described framework recently offered by Rachel Tecott and Andrew Halterman.[1] Although I provide a limited analysis here, the results strongly suggest that any predictions by either adversary would be unreliable.

For this type of contingency, computations should seek to establish feasible upper and lower bounds related to the performance of each country's respective command and control networks, submarine and anti-submarine warfare operations, missile attacks against key infrastructure and naval ships, missile defense systems, and other military systems. But, as the analysis in this paper demonstrates, one set of plausible modeling inputs, parameters, and assumptions could easily forecast a Chinese victory, while another comparably credible set could imply a U.S./Taiwan/allied victory. And this is even when accounting for a specific level of geographic and military escalation. As such, policymakers on both sides could not be certain that their own nation's war plans would be successful. The dangers of escalation would add even more uncertainty to the situation.

With this in mind, the implications for force planning for the United States and its allies (and probably China as well) are discussed here. What becomes crystal clear is that both sides should avoid this type of war, now and in the future.

INTRODUCTION

Beijing considers Taiwan an integral part of Chinese territory that must be reunified with the mainland.[2] The United States views the island polity of 23 million people as an impressive democracy, a high-tech industrial power, and a good friend, even if not a country or a formal ally. The previous commander of U.S. Indo-Pacific Command thinks China may try to settle the issue with force, perhaps even within the next five years or so.[3] This is certainly a credible statement, as tensions are clearly high. Various incidents involving close approaches between Chinese and Taiwan military forces rose by 30 to 100% or more from 2019 to 2020, demonstrating the increasing acuteness of the situation.[4] And the trend continues; for example, in 2021, China conducted a record number of military aircraft sorties into Taiwan's self-declared Air Defense Identification Zone.[5]

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But can China conquer Taiwan? Throughout the Cold War, and for some time after, the answer was a clear no. Despite China's proximity to Taiwan, U.S. dominance in advanced air and naval weaponry during that time meant that it almost surely would have defended Taiwan successfully. But today, the answer is less clear. Because of China's recent and dramatic military modernizations, the situation is now much more complex.

Many Americans still seem to think that the United States could prevail in defending its faraway friend. For example, most arguments in favor of retaining "strategic ambiguity" — basing any possible American military response to a crisis on Washington's determination of who and what caused the crisis — presume that whatever America's declaratory policy is, Washington will be able to back it up with military power.[6]

By contrast, Chinese thinkers seem increasingly confident that the U.S.-China military balance is shifting in their favor. In the last half decade, Chinese grand strategists appear to have settled on a more ambitious and expansive vision for the nation — to broaden its influence not only in the western Pacific but also well beyond. By this logic, establishing superiority over the United States in waters near Taiwan is perhaps a necessary first step en route to regional primacy. Chinese President Xi Jinping also appears to be on a mission to reunify Taiwan with China on his watch, and to do so sooner rather than later.[7] Like the architects of Germany's Schlieffen Plan leading up to World War I, or the planners leading up to the U.S.-led invasion of Iraq in 2003, Chinese military leaders seem to be gaining confidence in their ability to achieve precise battlefield effects quickly. As the Pentagon's latest annual report on China's military puts it,

> "PLA [People's Liberation Army] views on escalation are informed by the notion that contemporary 'informationized' conflict, enabled by modern C4ISR [command, control, communications, computers, intelligence, surveillance, and reconnaissance] capabilities, provides leaders with sufficient battlefield awareness to calibrate military effects and elicit a desired adversary response. Many PLA strategists view warfare as a science, discounting the possibility of inadvertent escalation and the effects of the 'fog of war.'"[8]

Although China still accuses the United States of pursuing absolute military superiority, it now seems to have considerable confidence in its own prowess.[9]

In this paper, the analysis of a likely contingency strongly suggests that for at least the 2020s and probably well beyond, the outcome of a conflict over Taiwan is *inherently* unknowable. This remains the case even if the battle is assumed to stay within reasonably specific boundaries of possible escalation. There are simply too many major technical uncertainties for any prediction to be reliable. The most important single factor leading to this conclusion is the fragility of C4ISR networks. Due to the multistep and path-dependent interaction between opposing militaries, the fragility of these networks cannot be thoroughly tested and analyzed in advance. The uncertainties around undersea warfare and missile defense — as well as around the resilience and reparability of physical infrastructure, including ports and runways — also contribute to the unpredictability.

To use an analogy, it is as if before a Super Bowl between two very evenly matched teams someone attempted to predict with confidence which side would win. But here, the uncertainties are greater. The opposing militaries will not have been recently battle-tested in similar kinds of kinetic fights. And even without accounting for escalation to general or nuclear war, the geographic and temporal constraints of the battle will be far less rigidly predetermined than in a football game. Moreover, there are no real world examples of two advanced militaries fighting each other with the full complement of advanced conventional, space, and cyber weapons.[10]

The conclusion of the analysis here cannot be proved beyond any reasonable doubt, particularly since it employed simple models and unclassified data to generate the results. But for reasons discussed later, it is unlikely that planners in the United States or China could be confident about any outcome either, even with access to more complex models and more current data; the uncertainties associated with various contingency scenarios are too multidimensional and profound. Of course, it is possible for planners on one side or the other (or both) to develop believable theories and concepts of victory — perhaps akin, in some ways, to those related to Germany's war plans against France and Britain in 1914 and 1940. But any responsible planner or advocate of conflict should consider the distinct prospect of defeat as well.

The analysis here focuses specifically on an attempted Chinese blockade of Taiwan in the 2020s, using technologies already deployed or in the process of being deployed. The presumed purpose of the blockade is to squeeze, strangle, and thereby coerce Taipei into some form of subjugation to Beijing's rule — in other words, some variant of forced reunification. By international law, this blockade would be an act of war. But, of course, Beijing would likely argue that it was an internal policing matter and not be particularly impressed by critiques based on the courtesies that independent nation states are supposed to extend to each other. Once the blockade is initiated, it is assumed that the United States and Taiwan, perhaps helped by Japan and other countries, attempt to defeat the blockade. Their goal is to keep Taiwan's economy afloat, and its people alive and well, until China is forced to end the effort due to the attrition of its armed forces (with agreement as well on some kind of postwar diplomatic formula that satisfies all parties and preserves Taiwan's core equities in the process).

This type of blockade seems to be the most likely serious military threat to Taiwan. That is because China can pursue it, at least at first, with limited physical violence against the people of Taiwan, a people that, after all, China claims as its own. A blockade also has the apparent virtue of being reversible, or at least adjustable, should Beijing choose to de-escalate the conflict at any point. Beijing's approach would be somewhat akin to what Germany attempted against Britain in the world wars — but with a preponderance of advantages, based on relative size and scale and geography, that Berlin never possessed.

In this contingency, as opposed to an attempted invasion, trends in technology would favor rather than hurt China, since Beijing would be the party threatening large military objects like ships and airfields and ports.[11] Unlike an operation to conquer the small, nearby islands currently administered by Taiwan, notably Matsu and Kinmen and the Penghu archipelago, Beijing would seek to address the core issue:

the sovereignty of the island polity. (Indeed, seizing small islands could cost China greatly in international opprobrium and possible retaliation, without addressing the matter of central concern.[12]) In one overarching scenario, to minimize China's own vulnerabilities and deny Taiwan good options for an immediate response, PLA attack submarines, rather than surface ships or aircraft, might be the principal assets employed. Cyberattacks would likely support the physical operation. In a second scenario, Beijing might also escalate to the use of land-based missiles and aircraft, depending on the initial results.[13]

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China would not need to stop all ship voyages into and out of Taiwan. It would simply need to deter enough ships from risking the journey that Taiwan's economy would suffer badly. For example, to make the blockade seem humane, Beijing might grant passage to ships carrying key medicines — only requiring the ships to dock in China for inspection before heading to Taiwan under Chinese escort. Beijing might also tolerate air traffic into and out of Taiwan (at least at first, so as not to put at risk airplanes carrying large numbers of civilians).[14] Beijing might then propose a so-called reasonable political compromise, allowing a degree of autonomy for the people of Taiwan even under the general mantra of reunification.[15] This strategy would likely work best against what Owen R. Cote Jr. calls a "weak Taiwan," rather than a "strong Taiwan" willing to endure protracted hardship to survive and outlast the blockade.[16]

China would hope that non-U.S. companies operating ships would choose to forgo the risk of sailing to or from Taiwan's ports, thereby achieving the blockade's desired effects more through intimidation and fear than direct military action. This scenario is particularly worrisome given how small the U.S. and Taiwan merchant marine fleets are (together only about 3% of global capacity, or around 1,000 ships).[17] They might not be adequate to sustain the island polity's economy by themselves.

Because the two overarching scenarios and related assumptions are not comprehensive relative to the universe of possible scenarios, the following analysis first considers lower or optimistic projections of loss and then upper or pessimistic projections (from a U.S. point of view). Thus, a total of four estimated outcomes are produced (two for each scenario). The outcomes are defined in terms of attrition to major combat platforms, in particular ships of various types. The winner is the side that effectively annihilates its adversary's relevant military forces while retaining some fraction of its own. It is assumed that both sides have the logistics capacity to sustain their main combat forces in operations until attrition determines the eventual winner. Of course, that may not be the case in reality, meaning that there are additional uncertainties in the outcome of these scenarios above and beyond those emphasized here.

To be sure, no actual war would proceed as linearly as presumed here for computational purposes. For example, the nature of submarine operations and the effectiveness of anti-submarine warfare (ASW) would fluctuate over time. Each side would seek the best places to operate (given sonar conditions and other considerations), varying the intensity of their efforts based on the effectiveness of certain tactics as well as on the interplay between military operations and broader political dynamics in Beijing, Taipei, Washington, Tokyo, and other relevant cities. But the computational approach used here somewhat allows for changes in strategy, since time is not an explicit variable and the duration of the conflict is not defined. If the model correctly bounds the relative loss rates on the two sides, it will matter less over what time period the losses occur, at least in materiel terms.

Toward the end of the Cold War and for several years after, simple models were sometimes used to predict combat outcomes. For example, analysts such as Joshua M. Epstein, Barry R.

Posen, and John J. Mearsheimer used simple models or computations to predict likely the North Atlantic Treaty Organization's (NATO) success in a fight with the Warsaw Pact in and around the Fulda Gap in Germany; other analysts such as Eliot A. Cohen challenged these conclusions.[18] For Operation Desert Storm and the invasion of Iraq a dozen years later, models were used more to predict U.S. and allied losses and conflict duration than to predict outcomes — the already presumed outcome being an American and allied victory. Here, as with the Cold War studies, I focus more on predicting outcomes — who wins and who loses?

Although there are many public studies that include the modeling of China-U.S. combat scenarios (for example, by RAND Corporation), most of them focus on individual pieces of a confrontation. Here, the pieces are integrated into an overall scenario analysis, in an attempt to capture the key dynamics without oversimplifying them. The hope is that this type of simplified modeling will complement more complex modeling — representing a yin and yang in defense analysis.

As noted earlier, the analysis here focuses on two overarching scenarios of a blockade contingency, the second of which could likely follow the first. Here is a more detailed overview of each one:

- **Scenario 1: A maritime fight centered on submarines.** In this battle, China would use its attack submarines as the main lethal instrument of the blockade, targeting ships going in and out of Taiwan's ports with torpedoes and anti-ship missiles. Taiwan would be very hard pressed to challenge these Chinese submarine operations, unlike a situation in which China uses surface ships or aircraft. Beijing would also employ mines. To give the appearance of being humane and to maintain its self-declared legitimate claim as the rightful ruler of Taiwan, Beijing might eschew attacks against Taiwan's territory or people (except for the relatively small numbers of seamen aboard the targeted ships). It might also avoid attacking American assets in places like Japan in the hope of lowering the chance of U.S. intervention — or, if that intervention does occur, the chance of escalation.[19]

  The United States and Taiwan would presumably respond with a large-scale convoy escort operation, plus an anti-submarine warfare campaign in the waters near Taiwan. The United States and China would both attempt to use jamming technology, cyberattacks, and possibly anti-satellite weapons to debilitate the C4ISR systems of the other, with the goal of blinding and paralyzing various parts of the adversary's joint military operations.

  Ultimately, one side would begin to lose this limited war — losing substantial numbers of its valuable military assets and its cherished military personnel. But this would likely lead to escalation instead of a retreat, and, thus, a second less-constrained scenario could develop.

- **Scenario 2: A broader subregional war.** In the face of losses or a renewed, stronger response from the United States and its allies, China might build on its initial limited attacks and use land-based missiles, followed by an air raid. Beijing would likely target (1) assets including Taiwan's airfields, where anti-submarine warfare aircraft could operate; (2) U.S. airfields on Okinawa, Japan, and Guam; (3) U.S. ships in the region; and (4) Taiwan's ports, where commercial ships could be loaded and unloaded.

  The United States, Taiwan, and Japan would respond with attacks on Chinese missile launch sites, airfields in southeastern China, C4ISR assets in that same region, and ports.

In analyzing each scenario, various assumptions, inputs, and parameters are used. It is assumed that (1) anti-submarine warfare barriers cause anywhere from 5 to 15% attrition per attempted submarine pass; (2) torpedo and missile or interceptor kill probabilities range from 15 to 25%, to as high as 50% in some cases; (3) China has access to anywhere from 100 to 200 medium-range ballistic missiles to target surface ships at sea; (4) and American allies contribute anywhere from 10 to 50 surface combatants to the fight. Whether runways on Japan and Guam could be quickly repaired, or alternative airfields utilized, is also crucial — and also highly uncertain; thus, both possibilities are considered. Most crucially of all, the possibility of surface ships being found and identified at sea is assumed to be high in some cases and low in others, depending mainly on the survivability of C4ISR systems.

There are, of course, huge risks of escalation and long-term warfare with multiple phases.[20] The uncertainties associated with blockade contingencies are thus enormous, even above and beyond what I analyze here.

With the data limitations here, the analysis may not do adequate justice to actual military balances or all the potential courses of events. The findings should therefore not be considered something akin to a mathematical proof or a law of physics. However, anyone claiming greater prescience would have a difficult time demonstrating why it is possible to be so confident in a predicted outcome. The performance parameters of different weapons systems, generally untested against each other in battle, could vary even more than is assumed in the analysis here; the nonlinear cascading effects of multiple uncertainties are likely to make outcomes in the real world even less computable.

China should not see limited-force scenarios as somehow safe or controllable. And the United States should not necessarily respond to a Chinese blockade with a prompt counterblockade operation, if it can devise alternative approaches.

Nevertheless, the implications of this analysis are important for U.S. and partner force planning purposes. For example, they may suggest certain modifications or modernizations of key assets — especially related to C4ISR, logistics and ordnance sustainability operations, and ASW platforms within the U.S. military force structure — that could reduce America's vulnerability to defeat. But even more, the implications are important for how all parties think about crisis management and any use of force. China should not see limited-force scenarios as somehow safe or controllable. And the United States should not necessarily respond to a Chinese blockade with a prompt counter-blockade operation, if it can devise alternative approaches.

Beyond a maritime blockade, other types of contingencies, such as an invasion of Taiwan, deserve analysis and attention, too.[21] But they are less likely to occur. In an amphibious invasion, Beijing would probably have to make some very fraught moves, such as preemptively attacking U.S. aircraft carriers and land bases in the broader western Pacific region to prevent the United States from launching aircraft that seek to attack troop-laden assault ships. The last time a country attempted a preemptive attack on the United States in the Pacific — Japan in 1941 — the outcome was not good, to say the least. For China, an attempted amphibious assault would be a huge risk, with no going back if the effort failed. Xi Jinping or any Chinese leader would have to assume that if they authorized the attempt and it failed, they would be driven from power internally. And so far, China's leaders have not heavily invested in amphibious vessels.[22]

Again, a blockade is the most likely scenario, because while extremely serious, it would not put large numbers of Chinese, Taiwanese, American, and other lives at immediate risk (including the nearly 1 million foreigners who live on Taiwan[23]) in what would be a huge cosmic roll of the dice by Beijing. Yet it would still offer the prospect of strangling the island polity and economy into capitulation.

Regardless of the type of contingency, it is clear that China has many strengths today that it did not 70 years ago, and therefore, no one should consider the risks of any contingency to be modest or the likely gains predictable. The United States should further hedge against less likely but possible scenarios, as should Taiwan. To do so, the United States should acquire assets like unmanned underwater vessels and easily launchable unmanned aerial vehicles (UAVs) that can deploy swarms of sensors and missiles in the western Pacific. Taiwan should buy lots of rapidly deployable and smart shallow-water mines; anti-ship missiles that can be fired from shore batteries, helicopters, or UAVs operating from short runways; as well as more survivable C4ISR infrastructure so small cells of troops can target incoming Chinese ships and planes even if cut off from central authorities.

This paper first reviews the basic principles and concepts of modeling and wargaming, including their advantages as well as their limitations. It then details the Taiwan blockade scenarios sketched out above and the findings of a relatively simple analysis. Recognizing the enormous uncertainties involved — and following the guidance of storied Pentagon "whiz kid" analysts Alain Enthoven and K. Wayne Smith — the analysis considers that any quantifiable prediction must include relatively optimistic and relatively pessimistic projections that, between them, capture the most plausible combat outcomes. The analysis also adopts Enthoven and Smith's attitude that, in modeling and simulation, it is better to be "roughly right" than precisely wrong — simplicity and a focus on the big picture matter most, as discussed further below.[24]

MODELING AND WARGAMING — GENERAL CONSIDERATIONS

To gain insight into how battles might unfold, military analysts and planners often use modeling and wargaming. Modeling produces simplified representations of combat that ideally capture the main inputs to war, including weapons and supporting capabilities, and their effectiveness. It involves calculations and algorithms but usually boils down to fairly simple (if sometimes messy) arithmetic. Figuring out what performance parameters to assign to various inputs is often more challenging than the math itself. Wargaming ties together the results of individual battles into more complex multimovement campaigns and wars.[25]

As Joshua M. Epstein has convincingly argued, whether we "model" mathematically and systematically, or anecdotally and impressionistically, *everyone* who forms an opinion on the likely course of a given war is applying some perceived images and expectations.[26] What formal modeling does, simply, is require analysts to make their assumptions transparent and to support their predictions with some kind of historical, technological, or quantitative reasoning. Wargaming requires one to be attentive to the dynamics that arise when humans interact competitively over an extended period. Neither modeling nor wargaming is a complete substitute for intuition or military judgment, but both can inform — and usefully challenge — subjective prognostications.

The models and games need not be overly complex. Indeed, often the simpler ones do better, because they tend to emphasize the fundamentals of a fight. In warfare, there usually are enough high-level uncertainties that there is more to be gained by analyzing, debating, and understanding them than by getting bogged down in the specific performance parameters of a large set of weapons and the computational codes of an elaborate algorithm.

For instance, independent analysts' simple calculations about the likely course of Operation Desert Storm in 1991 were generally more accurate than the Pentagon's sophisticated computer runs (which were too complex for most to scrutinize and were also classified). The outside analysts broadly estimated that U.S. fatalities would total between 1,000 and 3,000 or so.[27] While virtually all their calculations were too pessimistic, the Pentagon's more elaborate models reportedly projected deaths up to several times these numbers. (Actual combat losses were 148 for both Operation Desert Shield and Operation Desert Storm; when accounting for accidents and other noncombat losses, about 400 Americans lost their lives.) Outside analysts focused less on the minute details of force levels and weapons performance and more on the higher-level aspects of the war. In other words, they asked these kinds of questions: Were the Iraqi forces well-trained? Were they likely to fight hard? Could they be largely isolated by a technologically dominant adversary who faced little to no time pressure in launching a ground operation and who could bomb for weeks if so desired?

Simple modeling helps avoid creating a false sense of precision just because of the elegance of the methodology. The aforementioned analysts understood that computations about combat depend greatly on variables that are often very hard to quantify. These variables include the quality of leadership, the effectiveness of any surprise, and troop morale. In many situations, the politicization of a military may degrade its effectiveness as well.[28] In the modern era, the increased vulnerability of command and control systems to attack — for example, in the cyber or space realm or through undersea fiber-optic cables — creates additional sources of uncertainty.

That said, complex models also have their utility — for example, for incorporating the effects of new weapons. Those who have the ability to employ complex algorithms as well as simple computational methods may benefit from doing both. In this paper, accordingly, computations done by the RAND Corporation are integrated into certain parts of the analysis.

Models may help steer us away from choosing war too soon as a policy option, particularly when there are less fraught approaches still available.

Given that the business of predicting war outcomes is very challenging, one might ask, why bother with it at all? One reason is that understanding what we *do not* or even *cannot* know is important in its own right. If a large body of human experience strongly suggests that warfare is inherently risky and unpredictable, the onus will be on policymakers who propose engaging in warfare to explain why it is necessary — and to explain how they have taken every reasonable precaution to minimize the chances of being surprised by the course of events. A good case in point is U.S. President George W. Bush's decision to engage in what some have called a "war of choice" to overthrow Iraqi President Saddam Hussein in 2003 — and even more, his administration's decision to do so with smaller forces than recommended by military officers or other analysts and without a well-developed plan for restoring order after Saddam was toppled. Greater care in preparation, and less confidence about the probable course of battle, would have been appropriate.[29] Models may help steer us away from choosing war too soon as a policy option, particularly when there are less fraught approaches still available.

BLOCKADE SCENARIO #1: SUBMARINE AND ANTI-SUBMARINE WARFARE OPERATIONS AT SEA

SCENARIO OVERVIEW AND ASSUMPTIONS

This scenario is built on the notion that China would use its submarine force and any mines it could deploy near Taiwan — but not other, more visible and vulnerable assets — to threaten commercial shipping to and from Taiwan and to challenge any naval forces that might seek to break the blockade. It assumes that China would be willing to risk its entire inventory of some 60 submarines (40 being quite modern and quiet and 20 less so) in the effort. It further assumes that, to hedge its bets and present as complex a threat environment as possible, China would arm 20 of the submarines with torpedoes and the other 40 with anti-ship missiles.[30] The Chinese submarines might hope to gain information from increasingly capable constellations of imaging satellites (radar and electro-optical), listening satellites, and land-based over-the-horizon (OTH) radars about the locations of convoys and warships. But they may or may not be able to sustain these kill chains in the face of American and allied attempts to interfere with them.[31]

The scenario also presumes that, to limit the risks of escalation, China would not use land-based missiles or aircraft. In addition, it assumes that neither side would attack land-based infrastructure — though all of these constraints are lifted in favor of what may be a more plausible, yet still horizontally and vertically limited, subregional conflict in blockade scenario #2, discussed later.

Taiwan's naval capabilities include 22 frigates of varying capacity, plus four destroyers and two submarines.[32] The United States has about 90 surface combatants suitable for ASW and air and missile defense operations.[33] It would not be able to devote all of these vessels to a single operation, but it might, under crisis conditions, plausibly deploy up to half. U.S. allies — including four of America's strongest military partners (Australia, France, Japan, and the United Kingdom) — might then contribute roughly 10 to 50 ships, given that between them they have about 100 surface combatants. That said, they may not, given the complex politics and strategic considerations each country would face in deciding whether to join the conflict.[34] Regardless, other countries might backfill naval deployments in other parts of the world normally conducted by U.S. forces so as to contribute to the overall war effort without directly confronting China.

Using these ships and other vessels, Taiwan, the United States, and perhaps one or two key additional allies such as Japan, Australia, the U.K., and/or France would attempt to break the blockade by creating a secure shipping region through which ships could approach Taiwan from the east and dock in its ports. Until its immediate approach near Taiwan, such a shipping lane would be in the deeper waters of the Pacific where sonar is generally more effective and where Chinese submarines would have to traverse the waters near their own ports and then potential ASW barriers between Taiwan and other elements of the "first island chain" like Luzon in the Philippines (though most submarines would presumably be out to sea before the blockade effort was initiated, so they could avoid some of these barriers at least in their first sortie).[35] Minesweeping assets would seek to complete the corridor by creating narrow safe passages near port entrances. The United States and its allies would use land-based aircraft from Okinawa and Guam (and perhaps other locations, too) in ASW operations, and to protect against Chinese aerial raids, but otherwise try to keep the fight at sea.[36]

Analyzing such a blockade scenario is, of course, challenging.[37] The below calculations simplify the effort by viewing it as an endurance contest between Chinese submarines on the one hand and U.S./Taiwan/allied ASW platforms on the other. Since the latter countries collectively have about twice as many escort ships than estimated here to be necessary for the operation, they could replace any ships that were lost for a time, while maintaining the integrity of the picket lines that delineate the safe shipping corridor. In the model, China wins if it destroys enough ships that the allies run out of replacements and can no longer maintain the necessary length of the pickets; the allies win if and when they sink all of China's submarines.

This may sound straightforward, but important, subjective questions about the scenario — such as how much economic pain Taiwan might be willing to tolerate before capitulating and which country might escalate if it began to lose the specific engagement postulated here — cannot be easily addressed. Regardless, though, any answer is unlikely to invalidate this analysis's conclusion that the outcome of a military battle of attrition is actually indeterminate. While the correct metric of victory may wind up being Taiwan's endurance in the face of hardship, or some other political-military-economic factor, it is difficult to gauge such intangibles in advance. Measuring the outcome of battle against such a highly subjective and inscrutable variable would likely make the results of any analysis even more widely unpredictable.

APPROACHES TO THE BLOCKADE

The specific tactical and operational concepts used by both sides would probably vary and change over time, as in past conflicts like World War II. China might operate submarines singly or in packs. It might send ships to hidden locations to refuel and rearm submarines or might try to route them to smaller ports on its mainland (returning back to original ports seems unlikely). The United States and its allies might move their picket lines up and down (north and south) to avoid detection, leverage data from fixed sonar arrays on the ocean bottom that have survived Chinese attack, and respond to what they learn about preferred Chinese submarine operational patterns. The allies could lengthen or shorten the picket lines as needed; they might even add another line or strengthen one or use aircraft in some parts of the line and ships in other parts. Most likely, each side would try various basic approaches over the course of the campaign.

As the initiator, China would always have the option of slowing the pace of submarine operations, in the hope that Taiwan's political will might waver even against a "leaky blockade" and that American naval deployments could not be sustained indefinitely. To counter this possibility, the U.S. and allies, in addition to considering their own embargoes and partial blockades of China, might develop multiple new locations within Japan and the broader region from which land-based air power could eventually deploy, so as to lessen demands on the U.S. aircraft carrier fleet.

SUBMARINE AND ANTI-SUBMARINE OPERATIONS IN WORLD WAR II

Although the first scenario in this paper presents a submarine versus ASW competition as an intense series of engagements over a fairly limited time frame, it is worth noting that it might not play out that way. In World War II, submarine operations and ASW went through a number of distinct phases and lasted for the full duration of the conflict.[38]

An important study known as OEG No. 51, done by the Operations Evaluation Group of the Chief of Naval Operations just after World War II, identified seven distinct periods of tactical engagement over the course of the conflict:[39]

- Submerged daylight attacks on independent ships, September 1939–June 1940
- Night surfaced attacks on convoys, July 1940–March 1941
- Start of submarine wolf packs; end-to-end escort of convoys, April–December 1941
- Heavy sinkings on the east coast of the United States, January–September 1942
- Large wolf packs battle against North Atlantic convoys, October 1942–June 1943
- Aircraft defeat of U-boats' attempted comeback and the forced adoption of maximum submergence, July 1943–May 1944
- German Schnorchel U-boats operate in British home waters, June 1944–end of war

To put it in narrative form, the sequence of events in the Battle of the Atlantic followed a course something like this: Germany's ability to threaten allied shipping across the Atlantic started fairly slowly. Once France fell, however, German submarines were no longer easily bottled up in the North Sea, where their limited range (and the mining of the English Channel) made it hard for them to threaten Atlantic shipping. Using France's Atlantic ports, they dramatically increased the loss rates for allied shipping — roughly doubling what it had been in 1939 — and approximately triple the rate at which allied shipping vessels were being replaced by new ones, making the attrition unsustainable. They benefited as well from "wolf pack" tactics; U-boats, acting in teams, monitored a wide swath of the ocean and, aided by shore-based radio, moved to intercept convoys of allied shipping vessels so that several subs could position themselves to sink the ships.[40] By 1942, once the United States was in the war, Germany no longer felt any reservations whatsoever about attacking American ships wherever they might be. That resulted in another boost to U-boat effectiveness and more unfavorable dynamics for the allies, which continued into spring 1943.[41] Monthly sinking of allied shipping cargo reached into the 600,000 ton range, with more than 1,000 ships being sunk in 1942 alone.[42] Both sides viewed this rate of loss as critical, given that it meant supplies to Britain would soon not be enough to keep its war machine going or its population fed.[43] Although U.S. ship production was increasing — the War Production Board had begun to fully reorient American industry away from commercial goods toward military materiel — new hulls were not yet numerous enough to make up the losses. Even on the cryptology front, things did not go well; Germany changed its encrypting machines in 1942, leaving the allies in the dark about the locations of wolf packs.[44]

Things started to go better for the allies in early 1943. Convoys began to enjoy cover and protection from aircraft (operating off small carriers or land bases) like never before.[45] By this point, the allies also had better radar technologies for detecting and attacking submarines when the threatening U-boats surfaced — as they had to do either to communicate with each other and shore-based headquarters or to attain their higher cruising speeds. The allies could also understand more German communications through signals intercepts and cryptology known as Ultra.[46] By 1943, shipbuilding rates for the allies had doubled since 1942, and exceeding loss rates fivefold, as loss rates declined at the same time.[47]

Several hundred ships a day enter and leave Taiwan's ports.[48] To break the blockade, the basic approach for the United States and Taiwan might entail deploying enough forces to the western Pacific to establish a relatively safe shipping lane east of Taiwan, extending several hundred miles from the island — roughly the distance that China could safely assume most ship traffic was headed to or from Taiwan. This means that, given typical ship speeds, as many as 1,000 commercial ships at a time could be within the protected region. The scenario here, however, assumes the number of commercial vessels would be in the low hundreds, as some ship owners would likely be scared off. In fact, it would take considerable effort to keep any appreciable number of ships engaged in trade with Taiwan, given the inevitable skyrocketing in insurance rates that would surely result from a China blockade. Taipei or Washington might be called upon to subsidize owners' insurance payments or to reflag ships with the promise of reimbursement to owners should the ships be damaged or sunk. Taiwan's own merchant fleet might also have to be devoted almost exclusively to trade in and out of Taiwan.

As precedent, commercial shipping has been sustained in the face of various prolonged threats in modern times — the Iran-Iraq War of the 1980s and Somali piracy in recent decades. Admittedly, these did not reach the magnitude of what conflict with China would likely entail.[49]

Because modern sonars can typically only detect quiet submarines located within 25 kilometers,[50] ships conducting ASW would need to be spaced every 10 to 20 kilometers (P-3 and P-8 aircraft operating from land bases could assist with the coverage, as well as ASW helicopters relatively close to the ships where they are based).[51] The scenario in this paper assumes that about 100 naval vessels would be involved in the overall operation, most of them American but some from the Taiwan navy and perhaps also the Japanese, Australian, and/or NATO armed forces. Most vessels would form two lines running eastward from Taiwan toward the open ocean; the protected corridor would be located between these lines. Some ASW ships would serve as convoy escorts and move with groups of commercial ships (typically dozens per convoy), as they traveled either east or west through the safe zone.

To carry out the mission, the United States, together with Taiwan and others, would also need to establish air superiority throughout a large part of the region.

Although the deployment of a large fleet of unmanned ASW platforms is unlikely in this scenario (lack of sizeable numbers at this time), numerous unmanned underwater vehicles might also be used to support traditional manned submarine "mother ships."[52]

To carry out the mission, the United States, together with Taiwan and others, would also need to establish air superiority throughout a large part of the region. An additional dedicated

ASW barrier would therefore be needed to protect aircraft carriers operating several hundred miles to Taiwan's east.

Mines placed in the approaches to the ports of Taiwan would also be a likely threat.[53] They have been responsible for most U.S. Navy ship losses since World War II.[54] In modern times, the U.S. Navy has stayed clear of waters where mines might be deployed rather than devised any particularly effective counter to them. The main alternative to avoidance, as outlined by my Brookings and Georgetown colleague Caitlin Talmadge, would be to conduct extensive clearing operations to create relatively narrow channels for movement — if enough time is available to do so and if the ships and aircraft undertaking the operations can avoid enemy attack.[55] To carry out the clearing, and repeat the process if needed, U.S. minehunters and minesweepers would of course operate near Taiwan's ports and the main approaches to those ports. Land-based or ship-based helicopters might assist them. Individual mine-hunting ships typically clear an average of one or two mines per day, assuming relatively fast operations; the disabling of a given mine often takes concerted and focused efforts even once the threat is located.[56] This means it could take a month or more for the United States to clear all the mines. Advanced mines with sophisticated fusing mechanisms or robotic features that reposition the mines autonomously would slow the rate even further. As such, if China could lay minefields with submarines and then find a way to lay them again, it might be able to continuously impede Taiwan's ability to restore shipping. But if Taiwan could stomach the interruption to commerce and the resulting economic pain, this particular threat would not likely be the determinative factor in any campaign.

MODELING OF THE ENGAGEMENT

In this simplified scenario, to attack a ship in the lane east of Taiwan, any given Chinese sub would likely have to transit three barriers:

- as it left port and entered the Taiwan Strait or other proximate waters (where American attack submarines might lurk);[57]
- as it entered open ocean, after passing through island chain barriers, and then approached the protected shipping corridor; and
- as it approached its target, since most modern submarines have self-contained sensors that only work within 50 miles or so.[58]

As noted, in the first element of the ASW operation, the United States would probably try to track and attack Chinese submarines as they left port. The U.S. subs would probably not loiter just outside port, since they would be vulnerable to mines, depth charges, and torpedo attacks if their positions were easily predictable. As such, this barrier would perhaps be tens of kilometers out to sea — underscoring why, as with the other ASW barriers, its effectiveness would be imperfect and probabilistic. The shallow Taiwan Strait and its vicinity would also present a difficult acoustic environment due to multiple reflections of sound waves, which would confuse sensors.[59]

The United States' Sound Surveillance System (SOSUS), which comprises fixed underwater surveillance arrays, may contribute to the effectiveness of the second barrier. In particular, arrays operating in specific regions where detection conditions are favorable may benefit from the so-called reliable acoustic path phenomenon. That is, they might do so *if* they survive the initiation of combat. It would be hard for Washington to predict that survivability in advance, since what China knows about the location of SOSUS systems and their ground stations may be unknown.[60] If resilient, the arrays may be able to detect, more often than not, most types of Chinese submarines as the subs transit from the shallow waters in and around the Taiwan Strait to the more open ocean.[61]

The last barrier might not be effective if the Chinese sub were using anti-ship missiles and had good targeting information about commercial or enemy vessels. However, if the C4ISR network were compromised, the submarine would need to approach targets simply to find and fix them, so either way, a submarine en route to its target would need to transit three barriers. Then, the submarine would have to reverse course and survive the gauntlet of the same three barriers en route to homeport, where it would rearm and refuel and then try its luck again.

Whatever happened near port, there would surely be additional layers of American ASW farther out to sea. Ships and aircraft would use active and passive sonar to listen for approaching submarines and for the sound of any torpedoes being fired.[62] Some ships would be larger destroyers or cruisers, such as those equipped with advanced Aegis radars, to detect any use of cruise missiles and attempt to defend against them. Depending on how effective the initial deployment of barriers proved, they might be reinforced at times. For example, P-3 and P-8 maritime patrol aircraft flying from Okinawa might drop expendable sonobuoys if a concentration of submarine targets was suspected.

Generally, the survivability of a Chinese submarine on a given sortie can be estimated by computing its odds of surviving each barrier on the way to, and on the way back from, its attack mission.

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One simple methodology for assessing the effectiveness of ASW operations assumes that the attrition rate per well-developed barrier might range from 5 to 15%.[63] This range accounts for variability in both the quietness and evasiveness of different types of submarines. Chinese subs would have to survive perhaps three types of pursuers during three different parts of their journey to or from home base.[64] This sounds daunting, but they may often succeed; after all, in 2006, a Chinese Song-class submarine unexpectedly surfaced within torpedo range of the USS Kitty Hawk aircraft carrier.[65] Modern submarines can often do fairly well at avoiding detection.

However, first consider an older Chinese submarine and assume that the ASW barriers each would have 15% effectiveness against the submarine per attempted sortie. The submarine would have an expected survivability of 0.85 × 0.85 × 0.85 = 61%. In other words, the submarine would only have about a three-in-five chance of surviving long enough to get off a first shot. To get off a second volley, it would need to transit six more barriers — first to get home to rearm and refuel and then to return to attack position — for a total of nine. To get off a third volley, it would need to survive running an ASW gauntlet six more times for a total of 15 evasions, and so on.

Once in a position to fire, a given older submarine might have six torpedoes aboard, each with a kill probability of 15 to 25%.[66] In this scenario, it is assumed that the sub will fire at any ship it sees, commercial or naval.

So, focusing on the torpedo threat of an older attack submarine operating autonomously, which each U.S./Taiwan/allied ASW barrier has a 15% chance of finding and destroying, the math would go something like this:

> *Older sub and more effective ASW*
>
> Probability of getting into firing position on first sortie: 0.85^3 = 61%.
>
> Probability of getting into firing position on second sortie: 0.85^9 = 23%.
>
> Probability of getting into firing position on third sortie: 0.85^{15} = 9%.

According to these odds, the typical older submarine would likely only manage to fire on a convoy of ships once before meeting its demise. Of course, some submarines would not even get off a single shot, while others might manage three or even four salvos.

> Kills per sub = 1 sortie per sub per lifetime × 6 torpedoes per sortie × 0.15 to 0.25 success rate per torpedo. = (1) × 6 × (0.15 to 0.25) = 0.9 to 1.5 successful torpedo attacks per sub.

Rounding off, the Chinese submarine might kill, on average, 1.0 to 1.5 ships before it is destroyed. If there is roughly one escort ship for every 10 cargo ships, with the submarine firing indiscriminately at whatever it detects first, that translates into 0.1 to 0.2 naval ships sunk per older submarine. By contrast, if the submarine could distinguish between naval vessels and other ships (or get such information from aircraft and/or surface ships, with their various possible means of detection), the kill average could be as high as 1.0 to 1.5 naval vessels.

It is hard to know what is more likely: the lower end of this range or the higher end. Perhaps China's "triplet" satellites[67] could detect electronic emissions from U.S. Navy ships and pass the information along to submarines, and perhaps China's imaging satellites could do the same, when properly positioned geographically. However, both types of detections seem relatively unlikely in a wartime environment. U.S. Navy ships can use radio silence, and/or decoys, to try to fool the triplet satellites. And the odds are against imaging satellites being properly positioned at any given time. The United States might also consider directly attacking imaging satellites, if it could not reliably jam their communications.[68] The uncertainties are significant.

If things went very well for the United States, it might lose only a few ships, while sending 20 Chinese submarines to Davy Jones' locker. If things went badly, however, it might lose most of the force it had deployed to the region.

Nevertheless, according to the above stylized calculations, should China devote 20 older submarines to this operation, it could sink anywhere from two to 30 U.S. (or allied) naval ships — but it would ultimately lose all 20 of these older submarines.[69]

The same basic kind of math could then be applied to attempted torpedo attacks by modern Chinese submarines, which each U.S./Taiwan/allied ASW barrier has only a 5% chance of finding and destroying:

Modern sub and less effective ASW

Probability of getting into firing position on first sortie: 0.95^3 = 86%.

Probability of getting into firing position on second sortie: 0.95^9 = 63%.

Probability of getting into firing position on third sortie: 0.95^{15} = 46%.

Probability of getting into firing position on fourth sortie: 0.95^{21} = 34%.

Probability of getting into firing position on fifth sortie: 0.95^{27} = 25%.

According to these odds, a typical modern submarine would survive long enough to conduct about three separate attacks with six torpedoes each — three times the average for the older subs. That translates into roughly 0.3 to 4.5 naval ships sunk per submarine lifetime. If willing to use and ultimately lose 20 modern submarines in the effort, China could sink six to 90 U.S., Taiwan, and/or allied naval vessels. The higher end of this range would be more likely if submarines could distinguish warships from other vessels and attack the former preferentially. And it would thus amount to most of the U.S.-led armada initially deployed to bust the blockade.[70]

Between two and 90 is obviously a very wide range. Perhaps it could be narrowed with more precise calculations. Then again, previous modeling exercises and World War II history show that there can be wide swings in submarine and ASW effectiveness based on tactical and technical innovation.[71]

The key point is that neither Beijing nor Washington could be much more precise in its estimates of likely combat losses. If things went very well for the United States, it might lose only a few ships, while sending 20 Chinese submarines to Davy Jones' locker. If things went badly, however, it might lose most of the force it had deployed to the region — and thus no longer be capable of maintaining a protected corridor unless it sent reinforcements, many of which would likely not have Aegis-quality missile and air defense systems.[72] China could then use its remaining submarine force to decimate commercial shipping.

As noted earlier, the scenario in this paper assumes that China would arm 40 of its 60 submarines with anti-ship missiles. This is because China has about 40 submarines that can typically each carry six anti-ship cruise missiles.[73] Notably, the Chinese versions of the Russian-designed subsonic SS-N-7 and SS-N-13, known by designations to include YJ-82, C-802, and YJ-18, have approximate ranges of 50 to 200 or more kilometers and estimated kill probabilities in the high double-digit range.[74] Because these submarines could fire their missiles from a distance — if not the full 50 to 200 kilometers, given the potential need to find a target on their own, then perhaps at least several dozen kilometers — they could likely fire a salvo of missiles and escape before being counterattacked.[75]

The offense-defense balance involving missiles and missile defense continues to favor the offense quite strikingly. According to one estimate, in the late 20th century (the period with the most data in the modern era), more than 90% of missiles fired at undefended ships reached their targets (with 54 ships sunk or otherwise put out of action with just 63 missiles fired).[76] About 68% of missiles fired at ships that had partial or imperfect defenses, likely featuring jamming, reached their targets (with 19 ships sunk or put out of action using 38 missiles). Against ships employing their defenses, about 26% of missiles fired reached their mark (with 29 ships being incapacitated in one way or another by a total of 121 missiles fired). Of course, there is variation in the data; in some cases, for example, multiple missiles may have been fired nearly at once at the same ship. But the overall trends are telling about the difficulty of defense in the modern era. And there is little reason to think that the balance has shifted much in recent years.

To be sure, missile defenses have improved considerably since the 20th century, with medium-range defenses like the Terminal High Altitude Area Defense system and the Navy Aegis system being particularly impressive in tests against ballistic missiles or cruise missiles. But China's supersonic and, someday, its hypersonic anti-ship missiles provide more potent offense capabilities as well. The U.S. Navy's close-in weapons system, essentially a Gatlin-gun-like anti-aircraft artillery system, could perhaps destroy some missiles on their final approach. But America's main defense capability would come from anti-missile interceptors, fired at an individual incoming threat; so, as long as this is the case, the offense will likely have the advantage.

In any given sortie of its submarine force — whether conducted as a single major wave of attacking vessels or in a more staggered way — China's 40 missile-carrying submarines could carry a total of some 240 anti-ship cruise missiles. Each American surface combatant would have the capacity for 96 to 128 interceptor missiles in its vertical launching system (VLS) launchers, which would be directed toward incoming missiles by their Aegis radars and battle-control systems (capable of tracking more than 100 targets at a time).[77] However, the launcher tubes are also used for anti-ship and land-attack weapons as well, so they would not necessarily be configured exclusively for air and missile defense. Assume, for simplicity, that each U.S. ship carries 50 interceptors. Thus, in principle, with a fleet of 100 ships, there could be several thousand interceptors on station and in position to help defend ships in the area. So, a simple saturation attack might not seem advantageous to China, since it could not easily exhaust those inventories of U.S. (and allied) interceptors simply by firing a larger number of offensive weapons.

But given the offense-defense balance required for modern war at sea, China might not need to employ such saturation methods. It could likely achieve penetration rates against missile defenses of at least 25%, in keeping with the numbers sketched out above. If China fired say five missiles, each with an independent 25% chance of evading ship defenses and detonating against the vessel, it would have a 79% success rate, with at least one missile getting through almost four-fifths of the time (whether they were fired in salvo or not).

Shooting five missiles at each ship, China would have enough anti-ship missiles on its 40 submarines to attack 48 ships. And, thus, with the above calculated success rate of 79%, China could damage or destroy 35 to 40 of them — most being U.S. or allied navy ships if it could distinguish naval vessels from other vessels. If not distinguishable, China would hit commercial ships more often, given their relative numbers, and therefore may sink only three or four naval vessels. If the U.S. Aegis system achieves historically exceptional effectiveness against Chinese missiles, this might lead to a lower level of attrition, or something similar, as well. Of course, both the U.S. and Chinese militaries might have a better sense of the actual probabilities of evasion and kill based on classified testing or stolen data. But such data could be incorrect or soon rendered obsolete due to innovations that one side or the other undertakes.

The above math concerns just the first salvo. Many submarines would refuel, rearm, and return for a successful second or third or more salvos. As in the earlier calculation, the typical modern sub might survive long enough to carry out three successful offensive sorties, during which weapons are launched; thus, the above numbers should be multiplied by three.[78] Depending on their ability to target navy vessels, the 40 Chinese subs armed with anti-ship missiles might therefore destroy anywhere from roughly 10 to 120 U.S., Taiwan, and allied warships before suffering annihilation themselves. The range of uncertainty could even be greater than this — given that a very specific kill probability for interceptor missiles is used for this scenario — but the uncertainties accounted for here (concerning targeting) are the predominant ones.

Combined with the estimated total losses from torpedoes, a range (with rounding) of some 12 to 210 U.S., Taiwan, and allied ships could be sunk or otherwise incapacitated before ASW barriers eradicate the source of the threat. The higher end of that range of course exceeds the total size of the deployed armada by more than 100%. What that really means is that China, under the most favorable assumptions and circumstances, would need slightly less than half of its submarine fleet to sink the entire enemy fleet sent to the vicinity. (To be precise, according to this math, China would need 100/210 x 60 = 29 submarines.) Even though the United States and its allies would have many surface combatants left in their worldwide naval forces (roughly the same number as the number of those destroyed), they would not be able to maintain two continuous picket lines once they lost half of their global totals (many ships would probably not be operational or available for one reason or another). Thus, a clear defeat for allied forces is a reasonable outcome to seriously consider.

SUMMARY FOR SCENARIO #1

It is worth reflecting on what creates the wide range of possible outcomes in scenario one. It is not so much the quietness of submarines and the typical attrition expected at any given barrier, whether 5%, 15%, or something else. Rather, it is the submarines ability to detect and shoot at their intended targets, as opposed to having to fire away at any plausible target given the difficulty of loitering and searching indefinitely. This factor is captured in the scenario through assuming that naval vessels are outnumbered 10:1 by commercial vessels, meaning that in the absence of good intelligence, 10 times as many torpedoes or missiles will be fired at commercial ships as at U.S., Taiwan, and allied surface combatants.

Another way to think about it is to ask, statistically, the odds of a given submarine on the hunt being in the right place when a convoy passes by. The targeting problem may not arise from confusion over ship type, so much as over whether *any* ship is detected. That, in turn, relates to the question of whether China could keep an intelligence network operating effectively enough to see ships from space or a high-altitude stealthy drone as the submarines approach Taiwan. If so, and if able to get that information to the submarines, more often than not the subs could make good shots at passing ships with their main ordnance. If not, they would have to hope that, in a region of sea at least several hundred kilometers wide north to south, a convoy would happen to come near them even though their own sonars might only work out to several dozen miles (the ships attempting to break the blockade would not only use sonar to hunt for the submarines, they would also employ jammers to try to confuse the enemy about their ships' locations).

It is doubtful that either side could protect large satellites from effective jamming or destruction in this kind of scenario. However, the expansion of satellite fleets to include hundreds of micro-satellites makes it unrealistic for the growing and demonstrated anti-satellite capabilities of the great powers to incapacitate a whole fleet one by one.[79] Nuclear detonations in space might do the trick, but only at the cost of making low Earth orbit regions inhospitable for everyone. Long-range drone aircraft, some of them stealthy, might also be able to supplant or replace any individual nodes in a sensor-shooter network that are successfully jammed or destroyed.[80] Jam-resistant waveforms, protected antennae, armed satellites, shielded satellites, and maneuverable satellites are all options to reduce the other side's abilities to hamstring its space operations.[81] It is quite plausible that China could keep a C4ISR infrastructure working well enough to find enemy warships and get information on their whereabouts to its submarines at least some of the time. This would be the case even if commercial ships turned off their automatic identification system as they entered the protected corridor en route to Taiwan.[82]

But then there are cyber vulnerabilities. They could disrupt the operations of small satellites and stealthy drones, making it harder rather than easier to keep C4ISR functional. A 2017 Defense Science Board study called into doubt whether *any* existing U.S. systems could reliably be impervious to debilitating cyberattacks. The same could well be true of Chinese systems.[83] Long-standing cyberwar expert John Arquilla makes similar points: he emphasizes the ongoing risks to computer and electronics systems from high-altitude nuclear explosions that could create electromagnetic pulses.[84] Both countries can surely do some damage to the other's main C4ISR systems with various forms of hacking, but it is unlikely that either knows how long such degradations would persist. This conclusion is related to the precepts of complexity theory, as applied to cyber systems, which underscore the challenges that result from networks that suffer several attacks in a path-dependent way.[85]

In sum, either side could feasibly become the victor under scenario one. And that raises the distinct possibility that whoever seems to be losing the war may escalate to something like scenario two.

TABLE 1

Results for Scenario #1 — War at sea

SPECIFICS OF ENGAGEMENT	PREDICTED WINNER	RELATIVE LOSSES
China employs entire attack submarine fleet to enforce blockade; U.S./Taiwan/allies intervene to break blokade; PLA C4ISR fails, so subs must act autonomously	U.S./Taiwan/allies	12 U.S./Taiwan/ally surface combatants; 60 (all) Chinese subs
Same scenario but C4ISR remains largely intact; China can selectively target enemy warships	China	100 U.S./Taiwan/ally surface combatants; 29 Chinese subs

SCENARIO #2: EXPANDED WAR, INCLUDING MISSILE STRIKES AND AIR RAIDS

SCENARIO OVERVIEW AND ASSUMPTIONS

Scenario one is built on the assumption of considerable restraint by all belligerents. That may not prove to be the case, at least not to the extent previously postulated. After all, despite the attempt to prevent horizontal (geographic) escalation and vertical (up to nuclear) escalation, scenario one would likely result in thousands of dead personnel on both sides of the fight. And at least one party to the conflict would find its core objectives in jeopardy.

Whoever escalates first would likely achieve some substantial short-term gains and cause significant attrition to enemy forces. But because both China and the United States have strategic depth as well as large military forces with substantial capacity for reinforcement, whoever takes that first blow would have options for recovery.

Scenario two still maintains certain thresholds or firebreaks against escalation. But it enlarges the battle to include the use of Chinese land-based missiles against Okinawa, Guam, and Taiwan, as well as U.S. and allied ships if China can find them. It also includes a massive air raid by China against any ships it can find near Taiwan, once it has damaged runways and otherwise hampered the operations of land-based aircraft. The scenario also encompasses American/allied attacks against military facilities in southeastern China.

For the United States, several key elements of doctrine point to the likelihood of early assertiveness in a future war: the Air-Sea Battle concept, subsequently renamed the Joint Concept for Access and Maneuver in the Global Commons; the Third Offset of the mid-2010s; Multi-Domain Operations, a concept promoted most enthusiastically by the U.S. Army and U.S. Air Force; and the 2018 National Defense Strategy and its 2022 successor. Sometimes implicitly, sometimes explicitly, they all sanction early attacks against Chinese missile launchers, airfields, ports, and C4ISR sites in southeastern China should war break out.[86] Certainly, if something like the pessimistic outcome sketched out above came to pass for the United States, there would be strong pressures to deprive China of its ports and other mainland assets facilitating a deadly submarine campaign against American and allied ships, as well as of its airfields and C4ISR infrastructure.

An escalation by a losing China also seems feasible. If its leaders saw the United States using air bases in places like Okinawa to fly sorties (for example, with P-3 and P-8 aircraft) that were killing Chinese submariners and to establish air dominance (for example, with F-22 fighters) in the airways east of Taiwan and over the protected shipping lanes, there would be powerful incentives to strike at the origin of those flights.

Whoever escalates first would likely achieve some substantial short-term gains and cause significant attrition to enemy forces. But because both China and the United States have strategic depth as well as large military forces with substantial capacity for reinforcement, whoever takes that first blow would have options for recovery — provided, of course, that its national infrastructure was not so severely hampered by cyberattacks or other paralyzing enemy actions that potential reinforcements were rendered immobile.

As the analysis below shows, this fight could go either way, just like scenario one. Even with access to classified information, neither Washington nor Beijing could likely predict otherwise with any confidence. Different but equally reasonable assumptions about the scenario can be made, and they plausibly lead to either a Chinese victory or U.S./Taiwan/ally victory. And neither of these dichotomous outcomes can be easily dismissed; there is enough open source literature and enough capacity to model or simulate the war's course to establish both arguments with fairly high confidence.

If China strikes first and its C4ISR systems hold up, the United States and its allies would be in serious trouble. America's ASW barriers would begin to break down, as land-based aircraft would no longer be able to help in the operation. Its ships at sea would become vulnerable to a subset of the 200 or more Chinese land-based ballistic missiles in addition to all the sub-launched anti-ship missiles already considered in scenario one — that is, those with anti-ship sensors (no unclassified number is offered for these in the latest intelligence community publications on the subject).[87] Its ships may also be vulnerable to a massive air raid that China could conduct after temporarily shutting down flights by land-based American and allied aircraft. Most likely, the United States would not be able to eliminate the land-based missile threat, though it certainly could cripple the ports from which Chinese subs emanated, meaning most of them would have to go elsewhere to refuel and rearm. Even if China were to run out of missiles in a month or so, and the United States were able to restore functioning facilities at Kadena Air Force Base on Okinawa and elsewhere, much of the U.S. Navy could be on the bottom of the Pacific by then, and the United States might not have enough ships left in its navy to replace what it had lost during ASW operations.

But if China's C4ISR systems are seriously degraded, and its missile inventories get depleted, the United States and its partners could dominate the waters east of Taiwan and preserve some semblance of a functioning shipping lane even after absorbing the hits on Okinawa, Guam, and Taiwan. Still, to survive the blockade, Taiwan would need to repair or rebuild at least some of the port infrastructure that China would likely strike hard and repeatedly for a time. That rebuilding could prove quite difficult and slow, given the fragility of modern ports and their dependence on huge specialized cranes that would make inviting targets. Again, much would depend on the resilience of the Taiwan people and political leadership.[88] In the meantime, the United States might offer its roll-on/roll-off and amphibious ships as complements to Taiwan's own merchant fleet. This would allow some trade with the island even in the absence of functioning cranes and other complex infrastructure associated with modern ports.

For simplicity, the second scenario here assumes that China escalates first. This is because the United States has no guarantee of being able to do so even if it wants to. China could still strike first with little warning given that its forces are already in position. In any case, who escalates first turns out not to matter too much, because even if China strikes first, there is still a chance the United States, Taiwan, and the allies can "win" the war, especially if the United States is willing to replace losses to its ships and aircraft in the region by drawing down capabilities from other parts of the world. So, even with making assumptions initially favorable to China, the outcome could go either way.

Neither side should like this scenario — even on each side's own limited terms — and, of course, neither should dismiss the possibility of further escalation horizontally and vertically. Nuclear threats could become part of the conversation. It is notable that China recently decided to grow its nuclear force to around 1,000 warheads after decades of much greater restraint. (The decision emanates from a desire not to be as vulnerable to nuclear blackmail or brinkmanship as it was in the past.) That new reality, once achieved, may increase the odds that any conflict would remain at the conventional level, where Beijing might think it could prevail.[89] But, alternatively, it may give Beijing the confidence to threaten nuclear attacks if it found itself on the losing end of a conventional fight and — given its disproportionately high interest in the outcome — to persuade the United States to back down. Quite possibly, rather than simply concede defeat, whoever was losing would have powerful temptations at least to use nuclear bursts high in the atmosphere or space to fry Earth-based electronics and satellites if it saw any utility in the effort.

The modeling of this scenario uses the following calculations. First, it estimates how many U.S. and allied ships China might damage or destroy with land-based missiles, since it is assumed that Beijing would no longer hesitate to conduct such strikes. Then, it calculates how well China could do at shutting down flight operations at major U.S. and allied land bases on Taiwan, Okinawa, and Guam. Third, with these latter flight operations interrupted, it estimates the damage that China could cause to shipping in and around Taiwan via a massive air raid — given the now clear skies near Taiwan (except for whatever carrier-based aircraft could reach the vicinity). Note that because it is unclear how much trade Taiwan would need to preserve to maintain the political will to keep up the fight, the modeling does not include detailed calculations of what fraction of its port infrastructure could be protected or rapidly repaired. Finally, the modeling estimates some of the effects of a likely American counterattack on bases in southeastern mainland China.

MODELING OF THE ENGAGEMENT

Chinese land-based missile attacks on U.S., Taiwan, and allied naval vessels

In recent years, China has developed land-based ballistic missiles armed with homing anti-ship munitions, specifically the DF-21 and DF-26. If China can preserve what strategist Christian Brose calls "kill chains" — linking land-based ballistic missiles to satellite information about ship locations — it will have good prospects of sinking naval ships with these weapons.[90] To be sure, Beijing will need terminal sensors on those weapons, since ships will often change direction, making their locations uncertain by up to 10 kilometers over the course of a roughly 10-minute missile flight. (More precisely, ballistic flight would take about six minutes to cover a range of 600 kilometers, fourteen minutes to cover 3,000, or something in between for a range in between.[91]) Attaining those sensors seems within the realm of the possible.[92]

In this scenario, it assumed that China would use 100 to 200 such missiles against U.S. ships (even if the PLA does not have this number of missiles with anti-ship capabilities now, it could quite soon). If each missile wound up penetrating defenses even just 25% of the time, that math implies 25 to 50 hits on ships, depending on how many missiles are fired — or 12 to 25 ship losses, if we assume two hits per ship are needed to sink it. (Historically, in the latter decades of the 20th century, two to four hits were typically needed depending on the ship's size.) There would be a similar range of ship losses if assuming just 100 incoming missiles but varying the probability of penetrating defenses between 25% and 50%.[93]

Chinese aircraft attacks on U.S. and allied air bases

As noted, the United States and any allies supporting the operation would need to dominate the skies east of Taiwan. That would be true under either scenario explored in this paper. Otherwise, China would likely conduct a massive air raid, or series of smaller raids, to attack shipping there. And it would have to a large extent the choice of when to carry it out, allowing for optimal surveillance conditions. Thus, in this scenario, China would undertake its best strategy for denying the United States and its partners control of the skies.

Establishing air superiority would be difficult for the United States and Japan due to the PLA Air Force's recent modernization trends, plus the limited options for basing U.S. aircraft in the region. Modern U.S. stealthy or "fifth-generation" aircraft, such as the F-22 and F-35, are still superior to Chinese planes, but China now has close to 1,000 fourth-generation fighters roughly comparable to U.S. aircraft such as the F-15 and F-16. And China can base perhaps 1,000 aircraft within several hundred miles of Taiwan. The U.S. ability to sustain air dominance would largely depend on access to land bases and the maintenance of aircraft carriers within a few hundred miles of protected shipping and flight corridors.

Without the use of land-based aircraft, it is dubious the United States could protect against a massive Chinese air raid. A RAND Corporation simulation estimates that China might be able to devote about 600 planes to such a raid. Using a basic model and some simplifying assumptions, RAND estimates that the United States could prevent such a surge force from reaching most of its targets only by continuously keeping some two wings of fighters or about 150 aircraft airborne near Taiwan. The United States and its partners would likely succeed in such an effort because, according to RAND's model, the United States' fifth-generation aircraft — its F-22s and F-35s, and to a lesser degree F/A-18E/F Super Hornets — could have almost 50% more lethality and up to 90% less vulnerability than even relatively modern Chinese combat jets.[94] But that assumes having reliable access to nearby air bases.

China would have powerful incentives to try to deny the United States use of land bases for aircraft.

Bases on Okinawa are about 750 kilometers, or about an hour, away from Taiwan; aircraft carriers might be kept roughly that close, too. But other bases in the area (for example, Misawa Air Base on Japan's main Honshu island and Andersen Air Force base on Guam) would be 2,500 kilometers or more away. That distance implies some eight hours of flying: three to get to station, two at station, and three to fly back. If it is assumed, as did RAND, that aircraft and crews are limited to a daily flight average of about six hours a day, then jets from Okinawa could average 1.5 sorties per day but those from the more distant bases only about 0.75 sorties per day. That means eight aircraft or so based on Okinawa's Kadena Air Base or on carriers would be needed to sustain just one on station near Taiwan. Sixteen aircraft or so based at Misawa or Andersen Air Force Base would be needed to keep one on station near Taiwan. Thus, keeping two wings of fighters aloft at a time could require about 10 times that number being based in the region, more than half the total U.S. military aggregate.[95] The United States could not sustain that degree of continuous aerial vigilance from aircraft carriers alone, even if it could somehow devote its entire deployable fleet to the mission (generally eight or nine carriers, given that at least one or two would generally be unavailable due to maintenance and repair downtime). Knowing this, China would have powerful incentives to try to deny the United States use of land bases for aircraft.

To be sure, any such Chinese attacks would be extremely risky, involving direct strikes against populous parts of Japan and the high likelihood of significant numbers of military as well as some civilian casualties. The United States could be expected to retaliate against targets on the Chinese mainland, including missile-launch sites (if known and fixed), airfields, and C4ISR facilities. Beyond their immediate effects, such American actions could start to blur the line between conventional and nuclear war. China's arsenal of some 200 DF-21 and DF-26 ballistic missiles in total can carry conventional and nuclear warheads.[96] Thus, a U.S. effort to destroy them or their launchers — once some had already been used — would risk being seen in Beijing as a counterforce strike against nuclear assets. To attack such targets, the United States might also find it necessary to attack Chinese air-defense sites near its southeastern coast, which some in the PLA might interpret as a precursor to bombing runs by nuclear-armed U.S. bombers. The land-based communications systems used to direct China's attack submarines also direct China's nuclear-armed ballistic missile submarine fleet. So, the predictable American reactions to any Chinese use of land-based weapons, including ballistic missiles, could put at risk elements of China's reliable second-strike nuclear force and thereby create incentives for Beijing to take nuclear risks of its own before losing too much of its deterrent capabilities.[97] These dynamics are in addition to those that China might face anyway simply by virtue of potentially losing a conventional conflict over Taiwan and therefore deciding to risk escalation rather than accept defeat.[98]

Leaving these broader dangers aside for the moment, the first-order question is, how effective would China's missile attacks on air bases in Japan be?

China has perhaps 1,200 short-range ballistic missiles, 400 cruise missiles, and additional medium-range ballistic missiles based near Taiwan.[99] It also has hundreds of additional missiles that could in principle be moved toward southeastern China before or during the conflict.[100] And of late, it has been building at least 100 missiles a year to add to the tally.[101]

Also notable, these missiles are now accurate enough to conduct effective attacks against airstrips and associated infrastructure.[102] This is a huge qualitative change — instead of lobbing large numbers of missiles toward small targets, in the hope that a few would reach their mark by serendipity, the odds are now squarely in China's favor. These missiles have expected miss distances, or "circular error probables" (CEPs), of just five to 25 meters, and the warheads have a submunition coverage, or "lethal radii," of say 50 meters. This situation stands in stark contrast to that of the 1990s and early 2000s when China's missiles had typical CEPs of hundreds of meters.[103] With such improved CEPs, China could now effectively bisect Taiwan's dozen or so military-grade runways with relatively modest salvos of missiles. They could do the same to airfields on Okinawa and, quite possibly, on Guam and more distant targets, too.

Thus, in the computations below, it is assumed that each Chinese missile has a reliability of 90% and a CEP roughly comparable to its lethal radius. With just eight missiles, the attacker could have a 99% chance of shutting down the runway by cutting it in half, rendering each segment too short for any aircraft to take off.[104] The calculations are as follows, determining the runway's chances of survival per shot:[105]

> Chances of survival after one shot: 1 - single-shot kill probability[106] = 1 - (0.5 x 0.9) = 0.55
>
> Chances of survival after two shots: 0.55^2 = 30%
>
> Chances of survival after four shots: 0.55^4 = 9%
>
> Chances of survival after eight shots: 0.55^8 = 0.8%

To be conservative, an attacker might target aimpoints on the left and right sides of a given runway to ensure complete coverage of its width. Perhaps something closer to 16 missiles rather than eight would be required. (The likely effects of missile defenses are addressed below.)

Other studies reach similar conclusions — typically, a dozen or so missiles could slice up runways enough to make them unusable and disperse submunitions that could destroy any aircraft parked in the open. A more comprehensive attack that also targeted hardened shelters and fuel tanks might require several dozen missiles. For example, a 2015 RAND study estimated that 60 cruise missiles could target effectively all the important infrastructure on Kadena Air Base, with more than a 90% likelihood of destroying any given target.[107]

The basic point is this: a country with more than 1,000 accurate missiles can surely shut down a dozen unprotected airfields with high confidence. That is roughly the number of airfields on Taiwan, Okinawa, and Guam combined. Modern missile defenses may push the number of missiles needed upward, but the outcome would remain the same.

It is doubtful the United States would find and destroy many land-based missile launchers, even as this scenario began to unfold. Launchers are mobile and often well hidden in woodsy or mountainous terrain — a reality that has hardly changed since the "great Scud hunt" (or not-so-great hunt) of 1991 in Operation Desert Storm.[108] Thus, while the United States will likely retain stealth advantages in its best aircraft in the years ahead, these aircraft, or any other sensor platforms, might not be much more effective in locating Scuds.[109]

In summary, the United States and its allies might have to rely on a limited number of military air bases in Japan and on Guam to support land-based flight operations. Of course, if the airfields are defended by effective interceptor missiles, China would first have to saturate the targets with enough incoming missiles to exhaust or evade the defense's supply. But given that one interceptor missile is needed for each incoming threat — or perhaps two or more for a higher probability of intercept — China would generally have the advantage, even in an era when missile defenses against garden-variety ballistic missiles are becoming rather effective.

The advent of hypersonic missiles may give China additional options for striking first at air-defense radars and missile batteries and then hitting runways with more traditional missiles.[110] In defense, jamming could help but would have limited utility in protecting fixed sites since not much terminal guidance is needed when the locations of targets are known in advance.[111] At best, the United States would probably intercept anywhere from one-fourth to three-fourths of incoming missiles prior to running out of interceptors. Even if they were to run out early on, China would only need to multiply the size of its attack by a factor of three to ensure reliable destruction of the targets.

That said, runways can be repaired, and aircraft in shelters can survive at least indirect or inaccurate fire (though probably not direct hits from precision-guided munitions in most cases).[112] Fuel supplies and munitions can be stored underground where they are less vulnerable. Under these conditions, an airfield could be operational again within a few hours of being attacked. However, some runway repairs could take days, even when teams and equipment are available and doctrine is scrupulously followed.[113] And if the bases were to be more thoroughly damaged, the repair process could take much longer. After all, a modern air base with extensive shelters and hardening is essentially a $2 billion to $3 billion investment in today's dollars. Such massive projects are not completed, or rebuilt, overnight.[114]

Putting this all together, if China needed 20 to 60 missiles to cripple a given airfield, it would have adequate missile inventory to damage several times over all of Taiwan's 10 airfields, Kadena Air Force Base and Naha airport on Okinawa, and Andersen Air Force Base on Guam.

Other airfields could come into play, though. Japan has close to 100 airfields and more than 100 hardened aircraft shelters. (Taiwan has roughly 10 airfields and 200 shelters.) Could some of these airfields provide backup, along the lines of the Air Force's new Agile Combat Employment concept?[115] There is precedent. For example, in Sweden, during the Cold War, each major military airfield was associated with about 10 additional runways —and sometimes sections of highway — that also had adequate logistics capacities to support flight operations.[116] Japanese doctrine encourages some similar contingency planning, but it is not clear whether it has been well financed or implemented.[117] It is also not clear if U.S. aircraft based in South Korea and the Philippines could be used in this kind of war; much would depend on how these countries saw the conflict. While such access is possible in principle, it does not seem assured today. Therefore, for the first days or weeks of a blockade, the United States and allies might need to provide air cover and aerial surveillance using only aircraft carriers.

A massive Chinese air raid after the missile strikes

If the United States and Japan have enough runway-repair equipment, they might be able to exhaust China's inventory of land-attack missiles. Assuming Taiwan could survive over that period, China might ultimately be on the losing end of this exchange. Eventually, the United States could move aircraft onto the repaired runways with much less danger of follow-on attack — though since it could never be sure of the extent of the remaining Chinese missile inventory, it would have to keep pilots on runway alert or something close to it, just in case. So, China would likely seek to profit from the temporarily safe skies around Taiwan to conduct its own air raids against shipping east of the island soon after it had shut down airfields. The emphasis would be on the region within about 200 to 300 kilometers of Taiwan, a region that Chinese jets could reach before additional American aircraft could be scrambled to meet them. In other words, in this zone, unless the United States were to detect and quickly act on Chinese preparations for an attack, it might only have access to aircraft already airborne and in position.

As in the earlier cited RAND analysis, it is assumed that China would use as many as 600 aircraft in the effort. Flying at normal altitudes, larger search radars on these planes could see out 300 to 500 miles before the horizon interfered with their views. Smaller radars on individual fighter jets would have ranges of about 50 miles. The ships they would be seeking would inevitably present large radar cross sections.[118]

It is also assumed that the United States would have eight aircraft carriers in position, each with about 50 planes (mostly F-35Cs and some F/A-18 E/F) dedicated to the air superiority mission. If the carriers were generally several hundred miles east of Taiwan, where they would benefit from a dedicated ASW barrier to enhance their own survivability, aircraft would need to be constantly airborne near Taiwan to maintain vigil against this presumed air raid. It would take about four planes to keep one constantly in the air and in position. Unfortunately, for the United States, that would translate into about only 100 interceptor aircraft on station at a time, when the earlier calculation shown suggested that two wings of fighters or 150 aircraft would be needed to have a good chance at shooting down the preponderance of Chinese planes in a raid. (That is itself an optimistic assumption given that ongoing Chinese modernization in stealth aircraft and air-to-air missiles is partially eroding U.S. air superiority advantages.[119]) The United States would be about one-third short on the needed number of planes, assuming all of its carriers remained safe and functional. So, unless it were lucky enough to detect preparations for the raid and send up aircraft before Chinese jets were in position, the United States would be unable to launch a reliable defense. Roughly one-third of the Chinese air armada or 200 aircraft could reach the necessary positions to fire weapons at U.S. and other ships near Taiwan's coast.

Even if a huge number of these Chinese attack planes were shot down by ship air defenses — say 10 or even 20%, a very high fraction by historical standards — more than 150 would remain. Assuming two anti-ship missiles per attacking plane, as well as a kill probability of 25 to 50% per missile, the surviving Chinese aircraft would carry enough ordnance to destroy 40 to 80 U.S. ships.[120]

The American and allied response

In this scenario, the next big decision would therefore fall to Washington. Absent a diplomatic offramp that produced a compromise and ceasefire, the United States would face a quandary. Should it capitulate and then encourage/pressure Taipei to do so, too? Should it escalate? Or should it replace lost assets, repair damaged airfields, and attempt to outlast China's inventory of missiles (so that it might eventually reestablish dominance in the maritime regions in and around Taiwan)?

Capitulation seems unlikely. By this point, an island where more than 1 million Japanese live would have been attacked; Okinawa is not the Senkaku islands. American fatalities would likely number in the thousands. Treating the Chinese mainland as a sanctuary to avoid crossing an escalatory rubicon would make little sense, and this approach would not accord very well with what military historian Russell Weigley called, in its various incarnations over the years, "the American way of war."[121] The United States has not historically been a peaceful nation — my Brookings colleague Robert Kagan's depiction of it as a "dangerous nation" seems closer to the mark[122] — and Americans are not peaceniks. The country's reaction to Pearl Harbor in 1941 and to the 9/11 attacks in 2001 are two apt examples. Moreover, the concepts behind recent Pentagon ideas, such as Air-Sea Battle and the Third Offset, envision attacks against portions of the Chinese homeland in precisely these kinds of situations.

Escalation to other regions or to the nuclear level would not be off the table. But even with the parameters outlined in scenario two, the United States and its allies would have other options. Chinese ports that service submarines, vulnerable airfields, locatable mobile missile launchers, and air defenses that complicate the United States' ability to destroy its target could all find themselves in the U.S. military's cross-hairs. Of course, any attacks on these targets would be urgent because the eight-carrier armada deployed east of Taiwan could not be sustained indefinitely and could not be relieved by an additional eight carriers.

If effective, these U.S. and allied attacks could recalibrate the submarine-ASW competition. Chinese subs would have to travel further to find places to refuel and rearm, perhaps to ports in northern China. Another big air raid like the one considered above would no longer be as viable. The ability of China to communicate with deployed submarines would be increasingly doubtful, even if Beijing could operate satellites and aircraft well enough to obtain positional data on ships attempting to break the blockade.

Essentially, the same dynamics discussed in scenario one would apply to the battle at sea, but with a greater likelihood of lower-bound attrition levels for U.S. and allied losses. Eventually, China would run out of (1) submarines, because they would be sunk; (2) land-based missiles, because their supply would be exhausted; and (3) operational airplanes that could reach Taiwan, since so many would have been shot down. And even if the U.S. Navy had to send back most of its deployed carriers after a period of six to 12 months or so at sea, by then, more land bases in Japan might have enough fuel, ordnance storage, and maintenance capacities to allow land-based U.S. (and perhaps even Japanese) air to substitute for naval aviation and ensure air superiority east of Taiwan. (Perhaps U.S. aircraft in South Korea could help, too, but again, this remains a wild card.)

From the United States' perspective, there is a reasonable chance its attacks would be successful. But the United States would need enough ordnance to sustain the campaign against targets in southeastern China as long as needed. And, at present, it does not have sufficient stocks, given (1) the expenditure of so many munitions in the campaigns against the Islamic State group and the Taliban in recent years and (2) its proclivity to underinvest in munitions. Indeed, the United States could exhaust its most advanced air-to-surface missiles in less than 10 days if careless in the pace of usage.[123] The United States would also need to ensure adequate levels of readiness in a combat air force that is currently smaller, and in some cases less ready, than in past years.[124]

China's main hopes would hinge on several possibilities, and if any of them came to pass, the outcome of the battle could be different. China could succeed in penetrating ASW defenses and sink or disable several carriers. It could mine harbors or shut down port infrastructure near Taiwan long enough that the blockade would work even if its submarine and missile campaign at sea was unsuccessful — especially if Taiwan's people and government lost their resilience to the prolonged campaign and its associated economic costs after a time.

China might also find ways to target U.S. and allied ships even without a functioning satellite constellation and without the ability to mass a single huge attack. For example, it might use stealthy drones that carry anti-ship missiles and are capable of autonomous search operations. Even relatively basic stealth can do much to evade defenses; for example, American F-117 fighters in Operation Desert Storm flew more than 1,000 sorties — including against well-functioning parts of the Iraqi air defense network and sometimes without jamming support — without suffering a loss. A Chinese UAV would only need to get within a few dozen miles of a targeted ship to allow identification and then fire missiles. It could also transmit target coordinates to other UAVs, forming a continuous line back to land-based missile launchers that could then strike, too. In the estimated 10 minutes that it would take land-based missiles to reach their targets, the carrier could only move about five miles; thus, if it did not know it was under attack and continued on the same rough trajectory, the missiles' homing systems would have a good chance of picking it up.[125]

Moreover, if China were to start running out of missiles, it might consider making more — doubling down on the old Bolshevik adage that it could turn them out like sausages, or at least to the tune of several hundred a year.[126] If China could again shut down land-based air operations from Taiwan, Okinawa, and Guam at a time when U.S. carriers had to return home for maintenance and refurbishment, it might reestablish air superiority even in regions east of Taiwan and be able to attack shipping that way once again. As such, there is little reason here to expect a definitive one-time fight to the finish.

TABLE 2

Results for Scenario #2 — Expanded war

SPECIFICS OF ENGAGEMENT	PREDICTED WINNER	RELATIVE LOSSES*
China strikes ships and airfields with land-based missiles, then launches massive air raid against U.S./allied ships; U.S. does not reinforce losses	China	40-80 U.S./Taiwan/ally ships; land-based assets on Taiwan, Okinawa, and Guam; and 400+ Chinese aircraft
Same scenario but U.S. and partners successfully attack sub bases and airfields on China, degrade Chinese targeting systems	U.S./Taiwan/allies, perhaps	Dozens of additional aircraft per country; much of China's military infrastructure in southeastern China

* Additional to those from Scenario #1

CONCLUSION

Any attempt to predict with confidence the likely winner of a war waged over a Chinese blockade of Taiwan seems bound to fail. The outcome of such a war is, as argued here, profoundly unpredictable. There are too many uncertainties at the tactical, technical, operational, and strategic levels. Even when accounting for specific, reasonable boundaries of escalation, it is hard to be sure who would win. After introducing the broader unknowables associated with possible horizontal and/or vertical escalation, the result of any fight is probably beyond anyone's ability to predict, including decisionmakers in Beijing and Washington — and this is regardless of how much classified data they have at their beck and call and how well they think they know their own minds and those of potential adversaries.

Any attempt to predict with confidence the likely winner of a war waged over a Chinese blockade of Taiwan seems bound to fail. The outcome of such a war is, as argued here, profoundly unpredictable.

Important policy implications flow from this analysis. The results suggest that should China attempt to strangle Taiwan, the United States should think more creatively and asymmetrically rather than launch an all-out blockade-busting effort. The United States might instead consider a concept of warfare centered on a multinational boycott and embargo on trade with China.[127] Those extreme economic sanctions could then be backed up by attacks on the sea lines of communication in the broader Indian Ocean region. If the United States were to fly basic medicines and other essentials into Taiwan on commercial aircraft during the crisis — and China did not shoot down those planes out of fear of causing an all-out war with the United States — it could keep Taiwan going long enough to improve the odds of a viable negotiated exit from the crisis that does not compromise Taiwan's core interests. With adequate preparation, including taking measures to improve the resilience of American allies against a potential Chinese economic embargo and boycott, the odds may favor the United States and Taiwan in this scenario. And the risks of escalation would likely be much less than with a direct and major military operation near Taiwan. This approach might reflect the concept that Secretary of Defense Lloyd Austin calls "integrated deterrence."[128]

Both China and the United States should be disabused of any idea that a blockade campaign is likely to stay limited and relatively benign. Many thousands of personnel would likely die, and escalation risks would be huge given the stakes at hand. Moreover, China should bear in mind that, while it may have the greater motivation in any conflict over Taiwan, the United States has a history of becoming highly committed to wars it enters.

In the years ahead, both sides will try to change the current correlation of forces in and around the Taiwan Strait to their advantage. The analysis here suggests that relative vulnerabilities in C4ISR systems would be the most important determinants of a blockade contingency, and, as such, they warrant the greatest relative prioritization for future investment.[129] The United States and its allies should focus on improving these systems; the resilience of the network matters even more than the lethality of weapons. Paying attention to relatively mundane matters is important, too — starting with the logistical sustainability of protracted large-scale operations at sea, and the adequacy of stocks of advanced ordnance. Other priorities should include shelters for planes, repair equipment for runways, expendable sonobuoys, and development of unmanned and inexpensive ASW platforms that can someday replace ships in a picket line like that discussed in this paper.

But whatever the various parties attempt, the profound unpredictability of any blockade contingency will be difficult to alter. Too many factors contribute to C4ISR fragility, and they will be very difficult to mitigate. Meanwhile, other technical uncertainties will likely grow as new weapons, many of them autonomous, are deployed. And the strategic uncertainty associated with possible escalation by the side that loses the initial battle — if not immediately, then perhaps months or even years later — will remain significant.

General David Petraeus's haunting rhetorical question about the Iraq war — "Tell me how this ends?" — is even more consequential and challenging to answer when applied to a U.S.-China contingency.[130] This is a war that needs to be deterred and averted. It would not end in some notional great finish that somehow resolves the Taiwan issue once and for all.

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