Lessons From Ukraine on How Drones Are Redefining Asymmetric Warfare

November 2025

RANE

GETTY IMAGES

GETTY IMAGES

Lessons From Ukraine on How Drones Are Redefining Asymmetric Warfare

Introduction

The Russia-Ukraine war has highlighted how accessible, cost-effective technologies, particularly drones, are reshaping modern warfare. Drones have become central instruments of cost-imposition, allowing Ukraine to inflict disproportionate damage on a materially stronger adversary at a fraction of the cost of traditional weapons systems. Far from the rapid win Russia hoped to impose, Ukraine has demonstrated that smaller states can leverage these technologies to survive, adapt and even impose sustained costs over the long term.

The case of the Russia-Ukraine war has also shown that technology alone is not enough. Ukraine's technological capabilities have been successful only because they were embedded within enabling conditions, choices made in peacetime and wartime, that made them scalable and sustainable. Fiscal and industrial capacity enabled development and replenishment, organizational flexibility shortened procurement cycles, political will allowed for sustained effort and geography allowed drones to showcase their potential in the battlefield.

These non-technological attributes, often associated with more traditional understandings of warfare, remain indispensable even in an era of rapid technological advances. This project's framework moves beyond technical performance and operational outcomes, to look at Ukraine's success as being less about drones and emerging technologies than about the conditions that allowed them to be replaced, innovated and integrated even under the pressures of warfare.

But the significance of these capabilities extends beyond the beginning of a conflict and into the bargaining range, as they have the ability to alter cost calculations in relation to the value of coercion. For the smaller states, the aim is rarely outright victory. Rather, it is to raise the costs and uncertainty of military action for the stronger state. Thus, by demonstrating the ability to impose sustained costs, these states can resist and deter military coercion, ultimately forcing larger powers to rethink military operations. The metric of success is not only the physical cost-imposition but whether the

presence of these capabilities raises the stakes enough that coercion becomes a riskier and less appealing option.

This case study also provides insights for other small states under threat by a larger state. For states currently at peace but facing stronger opponents, the lesson is that procuring these emerging, affordable technologies is insufficient unless paired with pre-war preparation across political, economic and organizational domains.

The diffusion of technology has lowered the barriers to entry for adequate defense while also presenting opportunities for significant cost-imposition. The scale of cost-imposition ultimately influences the strategic balance which we define as the relative distribution of capabilities between states. The scale of its imbalance or "gap," is measured not in absolute terms but in comparison to one another. When viewing coercion through the lens of bargaining, the strategic balance is seen through expected costs of coercion. If the expected cost of coercion increases while the value of coercion remains constant, the stronger state may hesitate or abandon its objectives. Thus, the change in strategic balance can be achieved with these capabilities before military operations begin.

We argue that the diffusion of technology has lowered the barriers to entry for adequate defense, while also presenting risks of escalation and instability. The lessons suggest that small powers, if coupled with several non-technological drivers, can leverage inexpensive innovations to deny adversaries strategic objectives, complicate their planning by increasing expected costs and in some cases deter or coerce outcomes once thought unattainable for weaker states.

First, we will analyze the Russia-Ukraine war by focusing on specific drone technologies used by Ukraine, as well as their costs and the scale of cost-imposition achieved against Russia. The second part of the research shifts to the non-technological attributes that enabled this success. Specifically, we will examine the crucial pre-war and wartime conditions and/or changes that made Ukraine's drone capabilities scalable and sustainable, specifically focusing on political will, fiscal and manufacturing capacity, organizational flexibility and the role of distance and geography. Finally, we apply these insights into other non-wartime case studies involving tense dynamics between a smaller and larger state, assuming that the smaller state is aiming to close the relative balance of power gap. By analyzing the relationships between China and Taiwan and Ethiopia and Eritrea, we explore how drones and the same enabling non-technological factors could be used by a smaller state to deny a larger adversary's ability to uphold the asymmetric power dynamic.

Ukraine-Russia

Overview

Ukraine's success in the ongoing war with Russia illustrates how a state can not only defend but impose costs on a larger power using cheaper technologies, rather than non-modernized but functional legacy systems. Though the lack of an established defense industrial base, as seen with the size and maturity in comparison to Russia, traditional defense procurement and lack of nuclear weapons may have constituted an automatic loss for a state in their position decades ago, Ukraine has shown great resilience, patriotism and the ability to rapidly innovate. By decentralizing and leveraging technology faster and more cheaply than its opponent, Ukraine has managed to defend itself and impose significant costs on Russia. The war vividly demonstrates that a nation doesn't need the most expensive, advanced weapons to impose heavy costs on a bigger opponent. Ukraine's use of readily available and manufacturable drones has offset many of Russia's traditional advantages in tanks, aircraft and artillery. Indeed, inexpensive unmanned systems and digital tools are shifting the balance of power, giving the opportunity for agile defenders to contest, harass and impose asymmetric costs on even the largest militaries.w

Uncrewed aerial vehicles (UAVs), especially small, commercially available drones, have become a centerpiece of Ukraine's strategy. It is estimated that about 100 different types of drones are in use in Ukraine, ranging from toy-sized systems to larger models with wingspans of almost 20 meters. These inexpensive

drones serve as Ukraine's eyes in the sky for reconnaissance and artillery targeting. Some are fitted to drop grenades or act as explosives. On a typical 1-mile frontline segment, dozens of drones from both sides may be airborne at once, providing constant surveillance and rapid strike capability at the small-unit level. This widespread drone presence helps offset Russia's numerical advantage in traditional assets, giving even platoons real-time intelligence and precision targeting previously available only to large militaries.

Crucially, these drones are extremely affordable relative to the targets they engage. A basic first-person-view (FPV) quadcopter rigged with explosives might cost only a few hundred dollars, yet it can destroy a tank worth millions. In the opening weeks of the full-scale invasion, mid-sized armed drones like the Turkish-made Bayraktar TB2 targeted vulnerable Russian convoys, destroying tanks, armored vehicles and air defense systems. By mid-March 2022, analysts had confirmed nearly 60 vehicle kills credited to the TB2. These included tanks, supply trucks and air defense units, often caught on highways or staging areas with little protective cover. As Russia improved its air defenses by mid-2022, larger, slower drones like the TB2 became less effective but Ukraine adapted by shifting to smaller mass-produced drones that could be deployed in swarms. As of July 2025, these small FPVs have accounted for 60-70% of damage to Russian equipment.

Operation Spiderweb illustrates how Ukraine converts inexpensive technology into outsized strategic effect. On June 1, 2025, the Security Service of Ukraine (SBU) executed coordinated long-range drone strikes against five Russian air bases across five time zones, reportedly

Russian Bases Targeted During Operation Spiderweb

employing 117 Osa FPV quadcopters, platforms that cost roughly $600 to $1,000 a unit, totaling a cost of $70,000-$117,000 (exclusive of logistics, clandestine staging and operator support). U.S. officials estimated around 20 aircraft were hit and about 10 destroyed. Ukrainian claims were higher but even conservative tallies represent a severe blow to a bomber fleet of roughly 126 strategic aircraft. Crucially, the operation was able to impose significant damage even with the use of cheaper systems. By contrast, a single Ukrainian FP-5 Flamingo cruise missile costs on the order of $360,000 to $850,000 for the airframe alone, with a full strike package running into the millions. A basic Tomahawk missile for a stationary land target costs roughly $1.4 million. The operation reiterated that the cumulative use of simple, affordable, manufacturable drones can inflict damage on par with precision missile strikes. This underscores a broader shift in modern warfare. Strength is no longer determined solely by who fields the most sophisticated systems but by who can combine accessible technologies with ingenuity and scale to erode an adversary's advantages and alter the cost balance of war.

Analysis

Political Will

Despite the diffusion of advanced and accessible technologies, war remains a fundamentally human event. Drones, software and other cost-effective platforms may provide new means of imposing costs on a stronger adversary but they cannot substitute for the determination of those who operate, adapt and sustain them. Political will and societal commitment remain the foundation upon which technological advantage rests. A government's decision to fight does not automatically translate into the willingness of society to bear the sacrifices of a prolonged conflict and without such support, the capacity to mobilize resources, innovate solutions and replace losses quickly declines. Civilian innovators, volunteer networks and communities across the country have contributed directly to the adaptation and scaling of drone technologies, filling gaps that state capacity alone could not meet. Accessible technologies may therefore narrow the material power gap but their effectiveness depends on the collective will to fight, endure losses and sustain adaptation over time.

Ukraine illustrates this dynamic clearly. While the overwhelming military and economic disparity between the two countries may have seemed to favor Russia, Ukraine's political will created the conditions to hold off the invasion. This motivation is rooted in centuries of struggle for self-determination, which was clear from the earliest days of the full-scale invasion. Ukrainian President Volodymyr Zelensky's refusal to evacuate, stating, "I need ammunition, not a ride," exemplified the country's readiness to resist. This early show of political will from the highest levels of government was met with an immediate and equally defiant response from the Ukrainian people. A poll conducted in September 2022 by the Kyiv International Institute of Sociology found that 87% of Ukrainians opposed any territorial concessions to Russia under any circumstances, even if it meant prolonging the war, reflecting the public consensus that yielding territory would only invite greater peril.

This political will translated into a whole-of-society mobilization, one of Ukraine's most significant advantages. Unlike Russia's top-down approach, Ukraine's resistance was driven by a mostly decentralized network of grassroots organizations and citizens. In the early weeks of the invasion, around 1,700 new local aid groups formed to fill critical gaps in the military supply and aid chains. This horizontal mobilization is not only a vital characteristic of the Ukrainian effort but a strategic benefit as their speed and flexibility often outpaced formal state channels, ensuring frontline units received critical equipment when it was needed most. The state then institutionalized this will through initiatives like UNITED24's "Army of Drones," which scaled from crowdfunding campaigns into a national procurement and production program. By 2023, drone procurement and output were reportedly up 100-fold from 2022 levels.

Ukraine's ability to impose costs using these technologies has depended on the soldiers who operate, sustain and endure alongside them. At the start of the invasion, tens of thousands volunteered for service out of patriotism, though the initial surge of volunteers was not enough to offset heavy casualties and the hard realities of attrition. As the war entered its third year, Ukraine increasingly relied on conscription to sustain the ranks, lowering the draft age from 27 to 25 in 2024 and tightening mobilization requirements. These measures reflected both the exhaustion of soldiers on their second or third tours and mounting recruitment challenges.

Public opinion also mirrored this trend. While 73% still supported fighting until complete victory in 2022, in July 2025 only 24% held that view, with 70% supporting negotiations that would end hostilities as soon as possible.

Yet political will in Ukraine remains resilient despite these strains. War-weariness is a natural consequence of prolonged conflict and especially a war of attrition but it does not equate to surrender or collapse. Although there are some limitations to voluntary resolve, such as draft dodging, government-led initiatives such as mobilization requirements and conscription sustain commitment. Civilian networks continue to support equipment, grassroots groups remain active and public support for sovereignty and independence remains high even as preferences on what victory looks like and how to achieve it shift over time. Ultimately, in warfare today, cost imposition still hinges on the resolve of those willing to fight, endure losses and adapt. Fatigue may shape the form of resistance but it has not undermined the broader political will that sustains Ukraine's defense.

Fiscal Capacity

Much of the discourse surrounding the diffusion of affordable military technologies emphasizes their disruptive potential – specifically how even low-cost tools can impose outsized costs on traditional heavy systems. Unlike traditional weapon systems, drones are deliberately designed as attrition-focused tools with inherently high loss rates. Yet the cost-imposition depends less on the individual unit price but rather on the ability to sustain their acquisition, replacement and integration at scale. Fiscal capacity – the ability of a state to mobilize and allocate resources effectively under conditions of high attrition – thus becomes a critical component. Fiscal capacity is both a material and institutional characteristic. It encompasses the macroeconomic stability that enables a government to continue funding defense during a prolonged conflict, the necessary allied financial support and the procedural frameworks that channel money quickly to frontline needs. Ukraine's experience illustrates that the affordability of emerging technologies is only relative. Thus, it becomes the decisive attribute that determines whether these "cheap" technologies can generate sustained cost-imposition during war and alter an adversary's coercion cost-value projection to shift the strategic balance of power.

Ukraine has translated this attrition logic into budgetary practice by making drones a central pillar of its defense financing. In January 2025, the Defense Ministry announced an additional 2.5 billion hryvnia ($60 million) per month dedicated to drone procurement, following an earlier 2.1 billion hryvnia allocation

in December 2024, funds that ensure continuous replenishment at the brigade level. In March 2025, Kyiv announced plans to acquire 4.5 million FPV drones in a single year, with the Defense Ministry allocating over $2.6 billion toward this objective — more than doubling the previous year's rate of acquisition. By April, Ukraine committed to devoting roughly one-third of its entire defense budget to high-tech systems, prominently including drones, with more than 165 billion hryvnia allocated to capabilities outside of the traditional defense-industrial base. Based on state budget allocations, reallocated funds from local budgets and volunteer-supported procurement, commercial technologies make up nearly half of defense acquisition spending.

This domestic effort is supported by two critical fiscal pillars: massive allied aid and wartime economic mobilization. The United States has committed over $128 billion in aid, while European nations have collectively given $266 billion, in addition to the European Union's long-term €50 billion Ukraine Facility package.

In 2023, Ukraine's military expenditures rose 51% to reach $64.8 billion, about 37% of GDP, the highest of any nation by a wide margin, reflecting the scale of the conflict. For comparison, even Russia, which also greatly expanded its military outlays, spent an estimated 5.9% of GDP on its military in 2023. While public contributions in the form of war bonds and crowdfunding campaigns and spending have denoted Ukraine's fiscal capacity during the conflict, their ability to absorb wartime costs has been shaped by long-term budgetary and strategic choices taken in peacetime. After the 2014 invasion, Ukraine increased spending by 72% by 2021, creating a higher baseline before the 2022 invasion.

If a small state were to impose disproportionate costs to a larger state in the future using cheap but effective kinetic technologies such as drones, it must take steps to ensure that they can sustain what could be a prolonged war of attrition. This includes setting and sustaining a credible but realistic defense budget, beginning earmarking shares of the budget into emerging systems, legislating flexible paths of procurement and redistribution of funds and ensuring that they can receive external support. Without such foundations, the promise of affordable technologies risks being rendered useless in the attrition of war.

Manufacturing Capacity

Since its independence in 1991, Ukraine's defense industry has moved from an inherited rigid Soviet system to a hybrid wartime ecosystem that combines industrial scale with a distributed do-it-yourself culture. In 2010, the state consolidated hundreds of plants under Ukroboronprom (Ukrainian Defense Industry), creating a national prime that ranks among the largest arms companies in the world. In 2014, with the onset of the war against Russian-backed separatist forces, Ukraine lost its only small-arms ammunition producer at the time, the Luhansk Cartridge Plant, which was looted and destroyed by pro-Russian forces. As a result, Ukraine became dependent on imports for basic munitions, highlighting the fragility of its defense manufacturing capabilities from the outset.

After 2014, Kyiv laid the groundwork for its new industrial base. The 2016 shift to the Prozorro e-procurement system set public procurement norms closer in line with the European Union, increasing transparency and widening access for smaller vendors. Between 2017 and 2021, the number of procurements increased fivefold due to this reform. Other reforms, such as the establishment of the Ministry for Strategic Industries in 2020, began bridging suppliers and export partners, while Ukraine's fast-growing technology talent pool fed workshop networks that would later prototype quickly and fill demands on the battlefield.

Ukraine's wartime industrial adaptation is most clearly reflected in the rapid expansion of drone production, which grew 120-fold in 2023 and by early 2024 included multiple firms capable of manufacturing long-range strike systems. By October 2024, official projections placed national output at up to four million drones produced per year.Beyond drones, Ukraine's broader defense-industrial base has scaled rapidly, with roughly 500 firms employing 300,000 workers by 2024 and a reported sixfold increase in production capacity that year. By early 2025, officials projected a potential annual output of $35 billion, over 30% of which was

already supplied to domestic forces, underscoring the extent to which Ukraine has substituted imports with homegrown capacity in munitions, armored repair and electronic warfare systems.

Innovation frameworks and external partnerships have driven this transformation. The launch of the BRAVE1 defense-tech cluster in 2023 linked startups, engineers and combat units, accelerating development across hundreds of electronic warfare projects. By 2025, over 1,500 companies and 3,500 projects were on the platform. Partnerships with Western firms and the establishment of local repair and assembly hubs have shortened supply chains and embedded greater production capacity inside Ukraine, as battlefield feedback has accelerated rapid adaptation cycles. Nonetheless, structural limits persist. Between 2020 and 2024, Ukraine was the world's largest importer of major arms. It continues to rely on external supply for complex platforms, specialized explosives and propellants and critical electronic components. Even with impressive wartime adaptability, the defense sector will remain partially dependent on foreign inputs and investment for the foreseeable future.

In summary, Ukraine's defense industry has transitioned from a disrupted, import-dependent system in 2014 to a rapidly expanding wartime base centered on drones and other affordable technologies. Through restructuring, external partnerships and decentralized innovation, production has moved from volunteer initiatives to industrial scale, demonstrating how small powers can leverage flexible mobilization to mitigate structural vulnerabilities against larger adversaries.

Organizational Flexibility

Organizational flexibility has proven as critical as technological innovation in allowing Ukraine to narrow the power gap with Russia. While drones have become the centerpiece of Ukraine's cost-imposition strategy, their effectiveness has depended on a defense establishment that adapted quickly to the battlefield's uncertainty. Unlike traditional militaries that rely heavily on rigid procurement cycles and centralized control, Ukraine's system evolved to absorb new ideas, mobilize civilian expertise and exploit opportunities in real time. Volunteers consisting of drone hobbyists and tech experts began working on creating Ukrainian-made drones in 2014 with one hobbyist drone unit, Aerorozvidka, developing a drone system that was used by the military by 2022. This gave Ukraine a risk-tolerant prototyping culture that the state translated into adaptability, ensuring that inexpensive technologies could be scaled into decisive tools, rather than waiting on legacy program procurement cycles.

Decentralization has been a defining feature of this flexibility. Small units at the front lines and ad hoc civilian groups were empowered to innovate, test and deploy drone modifications without waiting for lengthy approval chains. Whereas Russia's hierarchical command often slowed adaptation, Ukraine's flatter structure allowed operators and engineers to move from idea to implementation in weeks. In 2022, technologies were in service for roughly seven months before replacement. In early 2025, the complete feedback loop averaged four to six weeks. The rapid integration of frontline feedback into tactical practice meant that innovations such as improved drone targeting systems or improvised munitions could spread across units almost as quickly as they emerged. This dynamic significantly multiplied the value of Ukraine's modest industrial base. In July 2025, the Ministry of Defense simplified UAV operating rules and write-offs.

Equally important was the collaboration between state and society. Public-private partnerships connected engineers, university labs, volunteer makers and small domestic and international startups with the military, creating an innovation ecosystem that has blurred the boundary between civilian and defense sectors. By acting as an "enabler, not a bottleneck," the government shortened procurement cycles and cut red tape, allowing promising ideas to reach the battlefield faster, for example, with the establishment of BRAVE1. This broad mobilization of talent meant that Ukraine could compensate for its relative lack of traditional defense capacity, producing a steady stream of low-cost and effective drone solutions.

The result was a consistently favorable innovation cycle that allowed Ukraine to erode Russia's conventional advantages. Each successful adaptation has reinforced Ukraine's ability to impose asymmetric costs at scale. In this way organizational flexibility amplified the disruptive potential of drones, turning them into instruments that not only inflicted tactical losses but also reshaped the broader balance of power. This flexibility also reduced political dependence. Donor end-use rules have at times limited how Kyiv could employ Western systems. For example, Washington and some European nations restricted strikes inside Russia for much of the war, later loosening and, in 2025, partially retightening specific permissions. However, Ukrainian-made drones are not encumbered by foreign end-use conditions. Organizationally, privileged local development and decentralized adoption has given Kyiv more independence of action even while it remained materially reliant on allies for complex platforms. By leveraging agility over rigidity, Ukraine has demonstrated that even in a war against a materially superior adversary, the side that adapts faster can offset disadvantages and contest the battlefield on its own terms.

Distance and Geography

When considering the implementation of new cost-effective technologies to offset imbalances vis-a-vis a large-power adversarial state, geography and distance remain central, just as with conventional weapons. Range determines not only whether a smaller state can strike but how reliably it can impose costs on an opponent's logistics, industry and population centers. Geography is not merely about physical space but also the interaction between terrain, infrastructure, human systems and strategic choices, framed by the "five themes" (location, place, human-environment interaction, movement and region). Additionally, the "six essential elements" of geographical knowledge expand on these concepts covering spatial analysis, physical and human systems, environmental interaction and the application of geographic knowledge to problem-solving.

In the context of Ukraine, these elements intersect, creating both vulnerabilities and opportunities for resilience through the use of technology and adaptive strategies. Unlike small powers protected by distance or natural barriers, its long, flat 2,000-kilometer frontier with Russia allowed rapid mechanized incursions in the opening weeks of the 2022 invasion. Ukraine's major population centers, industrial hubs and critical infrastructure remain within range of Russian artillery and airpower, creating vulnerability and reinforcing Moscow's capacity for coercion.Ukraine cannot rely on geographic depth to delay a conventional assault or facilitate external reinforcement. This same lack of geographical barriers, which favor the invader, have been a persistent concern for Russia as it sees NATO's borders moving east over the decades as too close for comfort, particularly considering the proximity and openness of the European plains connecting Eurasia, posing a perceived existential threat for Russia.

Geography adds another layer of difficulty to Ukraine's war effort by complicating the flow of Western assistance. With Black Sea ports blocked mainly by Russia, much of Ukraine's exports and military supplies now move overland through Poland, Slovakia, Hungary and Romania. These routes, however, pose logistical challenges. A key obstacle is the rail system: Ukraine uses a 1,520-millimeter broad gauge, while the EU relies on the 1,435-millimeter standard gauge. Every crossing requires trains to be adjusted or cargo transferred, creating costly delays when speed matters most. Steps are being taken to ease these problems. The EU is funding projects to extend standard-gauge lines deeper into Ukraine and to reopen older cross-border links. But such infrastructure work will take years to finish. In the meantime, Ukraine's logistics remain vulnerable, both to Russian attacks and to the harsh limitations imposed by geography.

Geography, while a liability in many respects, has also given Ukraine opportunities to turn the tables. Its proximity to NATO countries keeps supply lines short enough to sustain a steady flow of weapons and equipment, even under heavy fighting. At the same time, Russia's reliance on fixed and concentrated assets, such as the Black Sea Fleet in Crimea or strategic bomber bases deep inside its territory, has created valuable targets for Ukrainian long-range strikes. The use of uncrewed surface vessels (USVs) and loitering munitions in the Black Sea has been especially effective. The sea's enclosed geography leaves little room for Russia to maneuver, allowing Ukraine to chip away at naval dominance without needing to field an equivalent fleet. Likewise, drones able to strike hundreds of kilometers into Russia have inverted the traditional distance premium, demonstrating that inland areas are no longer sanctuaries. In this sense, geography interacts with technological range to allow weaker states to transform vulnerabilities into cost-imposition opportunities.

Strategic Implications

The geography of the Ukraine-Russia conflict reinforces two enduring insights. First, proximity to a significant power magnifies vulnerability by compressing warning times and exposing critical assets to rapid and surprise attack. Second, geography is not destiny. When paired with innovation, external support and pre-war preparation, it can become a lever for resilience and, in some cases, even a coercive effect. Ukraine's ability to contest supply corridors on land, disrupt Russian maritime operations and strike deep into its rear illustrates how smaller states can use geography, combined with accessible technologies, to raise costs of coercion. Thus, geography remains central to how cost-effective technologies can be integrated and ultimately used to reshape the strategic balance.

(1) National Geographic Society. (1984). Guidelines for Geographic Education: Elementary and Secondary Schools. Washington, D.C.

(2) Geography Education Standards Project. (1994). Geography for Life: National Geography Standards. Washington, D.C.: National Geographic Society.

(3) US Army War College Press. Fox, Amos C. (2019). Lessons from the Winter War: Finland Against the Soviet Union, 1939–1940. Carlisle, PA. https://press.armywarcollege.edu/monographs/919

(4) RAND Corporation. Mazarr, Michael J., et al. (2022). Deterring China: The Taiwan Defense Strategy in an Era of Precision Strike. Santa Monica, CA Corporation.https://www.rand.org/pubs/research_reports/RRA1225-1.html

Lessons from Ukraine

The Ukrainian experience demonstrates that accessible, low-cost technologies, particularly drones, can reshape the balance between a smaller state and a materially superior adversary. Yet Ukraine's success is not explained by technology alone. Rather, it reflects the interaction of several enabling conditions, including fiscal and industrial capacity to sustain production, replenishment and organizational flexibility that shortens innovation cycles, political will to endure a prolonged contest and geography that both constrained and enabled new modes of warfare. These factors reveal that cost-imposing strategies only become credible when embedded in a broader ecosystem of state choices, resources and geographic realities prepared before and during conflict.

The next section applies these insights beyond Ukraine by examining other small state cases. The analysis will test whether the same enabling conditions: industrial base, political mobilization, fiscal resources, organizational structures and geographic context determine whether new accessible technologies can effectively alter coercive dynamics. In doing so, the study moves beyond Ukraine's specific wartime adaptation to a broader inquiry into whether and under what conditions can small states consistently leverage affordable, scalable technologies to impose costs on larger adversaries before or during conflict.

China-Taiwan

The Taiwan case is the closest contemporary scenario in terms of a smaller state facing a proximate major-power adversary but the pathway from technology to deterrence differs from Ukraine in crucial ways. Most clearly, Taiwan's challenge is maritime. The Taiwan Strait imposes an amphibious and air-sea contest rather than a large-scale land campaign, shifting the scale, tempo and geometry of the military coercion. China can attempt to open with standoff strikes, air/maritime exclusion and a blockade, while Taiwan, by contrast, must survive early strikes and then establish a logistics chain across water. Unlike Ukraine, which retained land resupply routes, in the event of a conflict Taiwan could be isolated, emphasizing the need for stockpiling and planning to disperse technological capabilities. Additionally, Taiwan lacks a NATO-style or similar treaty guarantee or formal recognition of their sovereignty. Rather they rely on informal coalitions that are not promised or automatic. These structural differences therefore mean strategic balance shifting must be front-loaded, hardened and maritime-centric.

Rather than trying to match China system for system, Taipei has moved toward deterrence by denial, emphasizing mobility, dispersion and survivability. The government's "Overall Defense Concept," often described through the metaphor of the "porcupine," emphasizes small, numerous and hard-to-target assets that raise expected costs for the attacker. Examples include coastal defense missiles, mobile artillery, sea mines, surface and underwater UAVs for saturation and distributed command-and-control (C2). The goal is not symmetry but a layered attrition opportunity that forces the adversary to pay costs early and repeatedly just to stage and sustain their attack. The logic follows a similar path to Ukraine's embrace of low-cost drones as an attritional counterweight to Russian mass.

Taiwan's ability to sustain this approach depends on more than strategy papers. Political will, which in recent years has hardened under pressure, will be central. After successive waves of Chinese military exercises and airspace incursions, civil defense updates have included household-level preparedness and public support has grown for higher defense budgets. Yet questions persist about Taiwan's reliance on U.S. guarantees, the trade-off between economic ties and defense spending and sustaining morale in a society that has not faced the direct crucible of combat. Unlike Ukraine, where survival against invasion created near-total mobilization, Taiwan must manufacture urgency before day one, including building and sustaining reserve readiness and a shared understanding that denial requires society-wide resilience.

That challenge is compounded by organizational culture. The porcupine doctrine is a defense strategy designed to deter or defeat a potential Chinese invasion by making the island "too prickly" to take over. Rather than trying to match the People's Liberation Army (PLA) system for system with large, expensive platforms like advanced fighter jets or warships, it requires not just buying the right systems but embedding them into training, logistics and command routines. Ukrainian forces had little choice but to innovate quickly under fire; Taiwan must overcome peacetime inertia to achieve comparable flexibility. There is, however, some visible progress in the form of a greater emphasis on coastal fires, camouflage and dispersed basing. At the same time, preferences for high-end aircraft or prestige naval programs that may prove brittle under saturation missile strikes remain.

Fiscal capacity tells a similar story. Taiwan has steadily raised defense spending, with plans to reach over 3% or more of GDP in the coming years. These numbers, however, remain modest against China's massive defense budget and the delays in U.S. arms deliveries, which are currently valued at more than $20 billion, highlight a gap between paper budgets and available capabilities. By contrast, Ukraine's wartime experience has been one of rapid resupply from partners, often outside normal procurement processes. Taiwan cannot rely on such wartime shortcuts; it must ensure that its stocks, training and systems are in place before a crisis arises since the island will be effectively cut off once hostilities begin.

Industrial capacity adds another layer. Taiwan is the world's leader in advanced semiconductor production but this strength does not translate directly into defense production. There are currently indigenous missile and shipbuilding projects in Taiwan. However, the country still relies heavily on imports for advanced systems despite recent steps toward joint missile production with U.S. firms in an effort to shift toward scalable, locally managed production of asymmetric weapons, echoing Ukraine's wartime surge in drone manufacturing. The difference is that Ukraine built capacity under wartime duress, while Taiwan is seeking to develop it preemptively.

The island's civilian tech base, universities like the state-run National Chung-Shan Institute of Science and Technology and maker communities are an under-leveraged asset for denial. Modeling Ukraine, Taiwan should normalize rapid adoption loops which include low-bureaucracy prototyping and field trials. A protected pathway for bottom-up ideas like Brave1 to move ideas into funded projects will matter more than a choice of a legacy system. The benchmark is not perfection but rather how fast Taiwan can absorb losses, iterate and put an improved system back on the battlefield.

Geography is both an ally and adversary that shapes the bargaining space and the war itself. The Taiwan Strait provides a natural buffer that complicates amphibious operations, requiring China to mass and sustain forces across a body of water under hostile conditions. This maritime barrier creates opportunities for Taiwan to concentrate on denial strategies. At the same time, Taiwan's proximity to the Chinese coast leaves it vulnerable to hundreds of PLA missiles and aircraft within range, compressing warning times and exposing critical infrastructure to early strikes. Unlike Ukraine, which can absorb blow inland relatively quickly and fall back on supply corridors from neighboring states, once the Strait is contested or blocked, resupply flows risk being cut entirely, making pre-war stockpiles and resilient logistics essential. This maritime dynamic is perhaps the single greatest difference from Ukraine. Taiwan must assume that no significant replenishment of munitions or fuel will arrive once hostilities begin. As for innovation, Kyiv must defend vast open land against mechanized invasion, forcing it to innovate under fire with drones and dispersed units. Taipei's challenge is survival under concentrated missile and air attacks, where early attrition and planned dispersed survivability matter most.

Taken together, these factors suggest how a Taiwan conflict might play out in relation to the broader findings of this study. If Taipei fully implements its porcupine concept, it could impose costs like Ukraine's drone campaigns but in a maritime theater. The early phases of a Chinese assault would likely focus on missile strikes to create runways and destroy ports, critical infrastructure and command posts. Taiwan's survival hinges on whether it can impose delays and high material costs on the invader for long enough to disrupt Chinese staging and logistics, particularly under the assumption that a large force from the United States is en route to intervene. If so, Beijing's calculus could increase the probability of effective deterrence from Taipei, causing China to miss its optimal window of opportunity to invade, as its demographics, economics and geopolitical upper hand may drift away over time.

The temptation to continue to rely on high-cost prestige systems is real and may continue to absorb considerable chunks of the military budget. If Taiwan were to fail to embed new technologies in the form of autonomous vehicles and unmanned vessels, it risks a costly conventional arms race that would likely fall short of deterring China. Conversely, sustained asymmetric integration would align it more closely with Ukraine's example, where smaller, cheaper systems bought space and leverage against a stronger adversary.

The broader implication is that accessible, low-cost technologies do not erase asymmetry but can reduce the imbalance gap. In both Taiwan and Ukraine, they offer relative gains that matter precisely because they impose disproportionate costs on a stronger adversarial, larger neighboring state. In that sense, Taiwan's story reinforces the central finding of this study that accessible technologies can shift the balance but only when paired with political will, organizational agility and sustained external support.

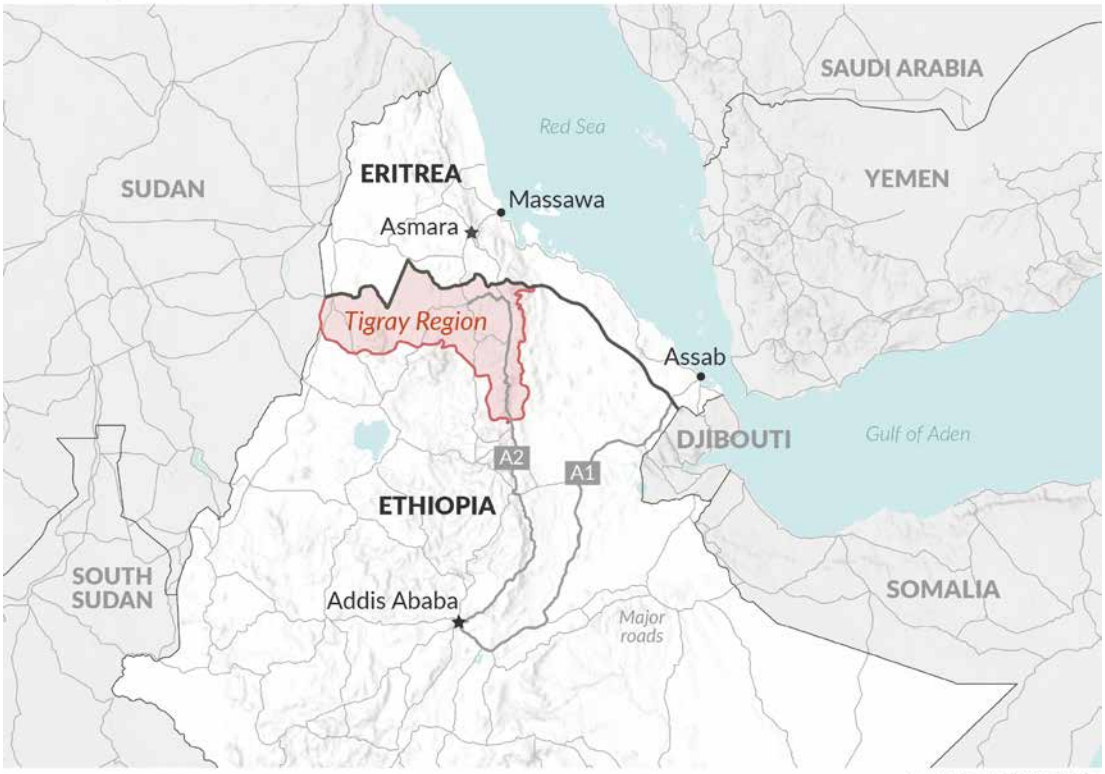
Ethiopia-Eritrea

The Ethiopia-Eritrea relationship represents one of Africa's most enduring state-to-state rivalries, with ramifications of years of war, uneasy truces and shifting alliances still unfolding today. Ethiopia's core objective of securing access to the Red Sea creates a clear coercive incentive. Eritrea's counter-objective is to make any military pathway to that end riskier and costlier than political or economic alternatives. In this bargaining frame, the question is not whether Eritrea can defeat Ethiopia but whether it can, at a tolerable expense, impose repeatable costs that alter Ethiopia's timelines, targets and acceptable risk.

Since Eritrea's independence in 1993 and the 1998-2000 war, mistrust has persisted despite intermittent peace efforts. After the Tigray People's Liberation Front (TPLF) war and the November 2022 Pretoria Agreement, relations have since deteriorated further. In September 2025, Prime Minister Abiy Ahmed publicly cast Ethiopia's loss of Red Sea access as a mistake to be corrected, reframing port access as both a historical claim and national security imperative. Against that backdrop, this case assumes Eritrea seeks to preemptively narrow the relative power gap by leveraging low-cost drones as asymmetric tools of cost-imposition.

Eritrea does possess several advantages that could make drones useful as asymmetric tools. Politically, an authoritarian system supplies mobilization and staying power even if coerced. Militarily, this translates into large manpower via national service. Fiscally, defense outlays absorb a high share of a small economy. It spends about 10% of GDP on defense and has one of the largest militaries in Africa relative to population. Geography further favors Eritrea. Its Red Sea coastline provides opportunities to deploy aerial and naval drones against Ethiopian infrastructure and supply chains, particularly given Ethiopia's dependence on foreign ports. In localized engagements, drones could allow Eritrea to impose disproportionate costs through harassing routes such as the A2, that runs from the Tigray region to the capital Addis Ababa, at a fraction of the cost of conventional weapons.

Ethiopia and Eritrea's Contentious Border



Copyright RANE 2025

Yet these advantages are undercut by structural weaknesses that limit Eritrea's ability to transform drones into a sustainable cost-imposer. The country's industrial base and economy is underdeveloped, characterized by poor governance, lack of structural reform and a stifled private sector, leaving it with few procurement channels and little fiscal capacity for long-term replenishment. Even cheap drones

require continuous supply of parts, skilled operators and adaptive tactics but Eritrea lacks the institutional flexibility and innovation ecosystems that enable rapid production and adaptation in high-attrition warfare. In comparison, Ethiopia has already demonstrated clearer pathways to sustainment and scale. Addis Ababa has both imported armed UAVs and recently moved to expand domestic drone production through initiatives such as SkyWin Aeronautics, giving it deeper procurement options and faster replenishment capacity than Eritrea is likely to achieve in the near term.

In the present, it is highly unlikely that Eritrea can close the balance of power gap with Ethiopia solely by fielding low-cost drones. Though drones would allow Eritrea to impose tactical costs, without major changes in fiscal resources, industrial capacity and organizational adaptability, the effects would be limited rather than transformational. However, several feasible developments could materially alter Eritrea's ability to use drones as a true equalizer. Russia has already deepened its defense ties with Eritrea, supplying drones, drone training and securing access to a future base in the east of the country which could provide the sustainment, further training and parts flows necessary to keep attrition-heavy drone operations viable. Additionally, deepening operational links with Tigrayans for intelligence, forward basing and logistics could magnify the operational reach of Eritrean strikes and complicate Ethiopian force posture specifically on key routes, such as the A2. Finally, the tensions between Ethiopia and Egypt could be leveraged for further support. Though gaps in the present remain a significant barrier if Eritrea were to wish to fundamentally alter the power balance, the combination of foreign material support and backing and Tigrayan collaboration illustrates how external alignments, as non-technological attributes, could supply the fiscal, logistical and political foundations Eritrea currently lacks, enabling Eritrea to move from episodic cost-imposition to a more sustained capability. While closing the gap is impossible today, a convergence of foreign assistance and regional rivalries could, over time, shift the scale of Eritrea's capacity to use drones as a meaningful counterweight.

Conclusion

This study began with a central question: Can the spread of accessible low-cost technologies change the cost assessment of larger powers, either altering their decisions about when and how to use coercion or force or extending the amount of time a small power can resist coercion? The case study suggests the answer is yes. These technologies do not erase asymmetry but they can increase strategic autonomy for smaller states by narrowing the power gap, complicating invasion or coercion and raising the price of aggression. While that narrowing may only be temporary, even temporary shifts can carry significance for regional power dynamics and growing multipolarity.

Ukraine offers the clearest example. These technologies have not reversed Russia's material advantage but they have imposed real costs, disrupted logistics, forced Moscow to adapt and extended Ukraine's capacity to resist. Operation Spiderweb is evidence of how low-cost capabilities imposed significant costs that traditional weapons could not at a comparable price. The measurable outcome has been Russia's need to devote greater resources to air defenses, electronic warfare and procurement. These adaptations illustrate that the bounds of power have not been permanently transformed but that Ukrainian innovation has forced Russia to adjust its operations at a significant cost, buying Ukraine both time and bargaining leverage.

The Taiwan case illustrates the potential for replication. If Taipei embeds mobile fires and sea denial systems into doctrine it can raise the expected cost of an amphibious invasion to the point of deterrence. In the Ethiopia-Eritrea relationship, it is clear that there are clear limitations with drones, as they are a tool rather than a self-sustaining system.

These technologies matter most because they are affordable and scalable. Unlike high-cost platforms that require years to procure and field, drones and loitering munitions can be deployed in large numbers and resist high attrition rates. This dynamic alters the calculus of risk for larger adversaries, forcing them to defend

across more domains and at greater expense. The result is a tangible narrowing of the power gap, even if only temporarily. This effect, however, is not absolute. These systems must be sustained by political will, organizational flexibility, fiscal commitment and industrial resilience. Reforms and Western partnerships enabled Ukraine's ability to scale drone production; Taiwan's success depends on embedding asymmetric doctrine across its force; Eritrea will fail to impose costs, let alone defend itself. In other words, technology alters the balance but whether that change endures depends on how effectively states integrate innovation into their broader structures of resilience.

Geography magnifies these effects. Ukraine's contested land border exposes it to constant pressure but also allows for sustainable Western resupply, despite the logistical challenges of integrating NATO-standard equipment with a country with a legacy of Soviet technology and infrastructure. Taiwan's insular geography complicates China's invasion planning and supply lines. Geography is a crucial factor in determining the appropriate technologies and doctrines to be adopted in each case. What proves successful in one place might not be replicable elsewhere. Open plains are more conducive for drone operations than dense rainforests; however, the principle of applying the appropriate innovative, low-cost solution to a specific environment remains. Larger powers can replicate or counter these innovations, leveraging deeper industrial bases and greater resources to eventually reassert their advantage, which could potentially change the dynamic in the long run. Russia's improvements in electronic warfare and air defenses against Ukrainian drones already illustrate this cycle of adaptation, within limits. The smaller state's advantage seems most pronounced in the early phase of adoption, when innovation outpaces countermeasures. However, we cannot underestimate the disruptive nature of these technologies and the opportunities they present for small-power states to alter the risk calculation of large-power adversaries, thereby changing the geopolitical calculations of both regarding deterrence and coercive options, even in the long term.

Ultimately, these technologies matter not only because they impose costs but because they expand the strategic options available to small states. They enable temporary independence from external patrons, strengthen deterrence and allow states to resist coercion for longer. That in itself is a form of strategic autonomy with wider implications for power balances. If small states can hold out longer and complicate aggression at a lower cost, they alter the calculations of larger powers and by extension, the stability of regional orders. The first-mover advantage belongs to the smaller state but the sustainability of that advantage depends on the environment in which they take place.

In short, accessible technologies such as drones do not overturn the bounds of power but they can recalibrate it in ways that shape strategic decision-making. They extend the timeline of resistance, complicate coercion and give small states a greater degree of autonomy. The challenge lies in distinguishing between temporary disruption and enduring transformation and in assessing whether the diffusion of such tools heralds a structural shift in how power is distributed globally or if it is just the latest turn in the long cycle of innovation and counter-innovation between large and small states.

Future Research

This study has demonstrated that accessible, low-cost technologies can significantly shift the relative balance of power between a small and a large-power state, though the stability and durability of this shift remain uncertain, partially due to the limitation of exploring the case of Ukraine since the full-scale invasion in 2022, which doesn't allow for sufficient time to collect enough empirical evidence on the evolution of these dynamics. Further work is needed to assess how long such advantages can be sustained before larger adversaries adapt. One line of inquiry concerns the industrial and organizational cycles required to keep these systems effective under wartime conditions: manufacturing, repair and doctrinal learning are as critical as the technologies themselves. Another avenue is the role of alliances in amplifying or substituting for domestic capacity. Ukraine's experience suggests that external partners are central to scaling production and innovation. Whether similar dynamics apply elsewhere

remains an open question. Another interesting aspect of the role that these technologies play in changing the dynamics between small and large power states is what happens with non-state actors, either between them, such as in the case of drug cartels in Mexico or between states and non-state actors, like in the case of counter-terrorism operations in many parts of the world. These aspects fell outside of the scope of this research but relevant findings are likely waiting to be explored in those areas.

Looking ahead

The emergence of accessible technologies in this study allows states with limited resources to impose costs at scale, complicate adversary planning and credibly threaten retaliation. These gains, however, are not guaranteed to last. Larger powers retain the ability to replicate innovations and develop countermeasures, meaning the advantage may shift over time, producing diminishing returns. Still, as long as the power gap is significantly reduced, albeit at a slower rate as time progresses, the effect will continue to be net positive for the smaller power state capitalizing on these opportunities. What is clear is that the initial phase of adoption favors the smaller power, offering a window in which deterrence is strengthened and coercive options are possible. For policymakers, the challenge is to recognize both the opportunity and the limitations. Small states can use these technologies to alter the calculus of aggression but they must combine them with resilient political, organizational and industrial structures if they want to endure. For larger powers, dismissing these systems risks strategic surprise, as recent conflicts have shown that relatively inexpensive tools can have disproportionate and costly effects. The contest ahead will not be decided by technology alone but by the ability of states, whether large or small, to adapt and integrate innovation into sustainable strategies.

RANE

info@ranenetwork.com

1-888-977-RANE

ranenetwork.com