Do Armed Drones Counter Terrorism, Or Are They Counterproductive? Evidence from Eighteen Countries*

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Abstract

Do armed drone programs decrease or increase terrorism? Existing studies on this question produce conflicting arguments and evidence. Drone optimists contend that armed drones reduce a country's vulnerability to terrorism, while pessimists claim that this military technology provokes higher levels of terrorism. Prior research focuses almost exclusively on one particular context: the short-term effect of the U.S. drone program in Pakistan. However, armed drones have proliferated rapidly over the last decade and eighteen countries now possess this technology. We expand the scope of prior studies by leveraging new data to assess how obtaining armed drones and conducting drone strikes changed the degree to which all drone possessors experienced terrorism between 2001 and 2019. Employing a variety of estimation strategies, including two-way fixed effects, we find that armed drone programs are associated with significant reductions in terrorism. Our analysis, based on the full universe of cases over an eighteen-year period, provides further evidence that drones can be effective as a counter-terrorism tool in some cases.

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Introduction

Are armed uninhabited aerial vehicles (UAVs), more popularly known as “drones,” an effective counter-terrorism tool, or are they counter-productive? Despite the increasing prominence of armed drones in international politics, this question remains contested among scholars and policymakers. Drone pessimists argue that they *increase* terrorism by causing blowback among civilians and empowering lower-level militants that have greater preferences for violence (Boyle 2013; Cronin 2013; Abrahms and Potter 2015; Rigterink 2021). Drone optimists instead argue that they *decrease* terrorism by disrupting and degrading militant organizations (Byman 2013; Johnston and Sarbahi 2016; Mir 2018; Shah 2018; Mir and Moore 2019). Since these two camps both make plausible theoretical arguments, and draw on different sources of data to support their claims, we need additional empirical evidence in order to adjudicate this debate.

Prior studies focus almost exclusively on the short-term impact of American drone strikes in Pakistan, as shown in Table 1. Micro-level studies offer significant advantages, especially the potential ability to make causal identification more feasible. One drawback of this approach, however, is the lack of context about the impact of armed drones on political violence more broadly, especially outside of the U.S. setting. Moreover, the advanced character of American drone operations may make the U.S. case a relatively easy test for the arguments of drone optimists. Table 1 also underscores that previous research focuses on the short-term (monthly, weekly, or even daily) impact of drones on terrorism, leaving the longer-term strategic impacts of drones unclear. Even many drone pessimists concede the tactical effectiveness of drones. Consequently, these previous studies may not provide the strongest test of their argument that drone programs undermine strategic counter-terrorism effectiveness in the long-term (Cronin 2013; Horowitz, Kreps, and Fuhrmann 2016).

To move the literature forward, we focus on the cross-national context, which is now possible because armed UAVs are proliferating rapidly around the world (Horowitz, Schwartz, and Fuhrmann 2022). In 2010, there were only 3 countries with armed UAVs, but 18 countries possessed armed drones by the end of 2019. Moreover, while only 3

Table 1: Quantitative Studies on the Relationship Between UAVs and Terrorism

Study	**Location of UAV Activity**	**Unit of Analysis**	**Timeframe**	**Relationship UAVs & Terrorism**
Johnston and Sarbahi (2016)	Pakistan (FATA)	Agency-Week	2007–2011	↓
Jaeger and Siddique (2018)	Pakistan (FATA)	Country-Day	2007–2011	Mixed
Mir and Moore (2019)	Pakistan (FATA)	Tehsil-Month	2002–2011	↓
Rigterink (2021)	Pakistan (FATA)	Group-Month	2004–2015	↑
This Study	Global	Country-Year	2001–2019	↓

countries (the United States, Israel, and the United Kingdom) conducted drone strikes from 2001 to 2014, since 2015, eight additional countries have carried out strikes: Pakistan, Iraq, Iran, Nigeria, the United Arab Emirates, Saudi Arabia, Egypt, and Turkey. Drawing on an original time-series cross-sectional dataset we created to measure the status of states' armed UAV programs from 2001 until 2019, we assess the impact of an armed drone program on terrorism *at the yearly level* for the full universe of potential cases. This wide-ranging analysis complements and extends existing micro-level research.

Identifying a causal relationship is difficult because countries are likely to seek armed drones when they already face significant threats from terrorism. This means that drone adopters may be fundamentally different than non-adopters when it comes to their vulnerability to terrorism. Additionally, countries may pursue other counter-terrorism strategies in tandem with armed drones. To address these concerns, we use two-way fixed effects (TWFE) and control for a wide range of observable factors associated with both terrorism and drone adoption. Country fixed effects leverage within-country variation in order to remove potentially confounding variables that differ between countries but remain constant over time, like geography, culture, and stable demographic attributes (Kropko and Kubinec 2020). Year fixed effects remove potentially confounding common time shocks that countries experience. This yields a difference-in-differences-like design, which is commonly used in the social sciences. Although TWFE is the most prevalent approach to estimating a difference-in-differences model, recent research shows that treatment effect heterogeneity can cause these models to yield biased estimates when there is staggered treatment adoption, potentially even causing the direction of the principal effect to be reversed (Imai and Kim 2020; Goodman-Bacon 2021). Therefore, we also estimate our model using a procedure developed by Callaway and Sant'Anna (2021) that addresses the potential bias resulting from TWFE. This analysis shows that, if anything, our primary model is a conservative estimate of the impact of armed UAVs on terrorism. Finally, we estimate models that exploit the gap in time between when states start pursuing armed drones and when they acquire them. Since countries pursuing armed drones are likely taking other steps to combat terrorism, comparing the period after a state acquires to the period when a state is pursuing helps isolate the effect of armed UAV acquisition on terrorism.

Across these tests and a series of robustness checks, our results consistently support the drone optimist camp. We find a statistically significant *negative* relationship between obtaining armed UAVs and conducting strikes on the prevalence and lethality of terrorism. Substantively, our primary models suggest that obtaining armed UAVs is associated with 5.5 fewer terrorist attacks per year, a 35% decrease. States that have conducted at least one drone strike reap even greater benefits, as they face 7.25 fewer attacks per year. Compared to other drivers of terrorism found in extant studies, these substantive effects are relatively large. Furthermore, a follow-up analysis of causal mechanisms is consistent with the argument that armed UAV programs undermine the capacity of terrorist groups by disrupting and degrading them.

In sum, our cross-national approach gains greater external validity (many more countries) and a better understanding of the longer-term strategic impacts of drone programs on terrorism (analysis at the yearly rather than monthly, weekly, or daily level), even though it sacrifices some causal leverage relative to micro-level studies. Our results contribute to both academic and policy debates over the effectiveness of armed UAVs, as well as broader debates regarding the efficacy of leadership targeting and air power (e.g., Pape 1996; Kocher, Pepinsky, and Kalyvas 2011; Johnston 2012; Price 2012; Jordan 2014; Blair, Horowitz, and Potter 2021). The evidence suggests that drones can be an effective counter-terrorism tool.

Two Perspectives on Armed Drones and Terrorism

The impact of armed drone programs on terrorism is still a source of significant debate in the academic and policy communities. Broadly speaking, there are two schools of thought. Drone pessimists contend that armed UAV programs increase terrorism, whereas drone optimists argue they decrease terrorism.

Drone Pessimists

From the perspective of drone pessimists, armed UAV programs harm counter-terrorism efforts. There are three principal arguments made by those in this camp: (1) problems of control, (2) civilian blowback, and (3) signaling and revenge.[1]

The first argument involves "problems of control," also known as principal-agent problems (Abrahms and Potter 2015; Abrahms and Mierau 2017; Rigterink 2021). The logic of this argument is that lower-level militants have greater preferences for indiscriminate violence. This may be the case for several reasons, including that lower-level operatives have shorter time-horizons, are likely to be younger and thus have a more limited understanding of the strategic pitfalls of utilizing indiscriminate violence, and have fewer resources at their disposal, which may encourage them to attack softer targets like civilians (Abrahms and Potter 2015, 316-317). Consequently, if armed drone programs undermine the control that leaders (principals) have over their operatives (agents), then that may—in accordance with the arguments of drone pessimists—increase the overall level of terrorism by enabling lower-level militants to act on their preferences. According to this school of thought, drones may also specifically increase the number and share of attacks against non-government (i.e., civilian) targets.

Several studies find evidence for problems of control. Most relevant to the question of UAV effectiveness, Rigterink (2021) analyzes the impact that drone strikes targeting militant leaders in Pakistan have on monthly levels of terrorism. Leveraging variation in whether UAV strikes targeting a leader hit or miss their mark, Rigterink (2021) finds that

[1] See Rigterink (2021) for an overview of these arguments as well.

successful strikes *increase* the number of terrorist attacks in three out of the following six months.[2] He also finds that the number of attacks against civilian targets increases. Abrahms and Potter (2015) similarly provide evidence for problems of control, finding that drone strikes in Pakistan increase the share of terrorist attacks targeting civilians. Nonetheless, they also present evidence that the total number of strikes against military targets *decreases*. Abrahms and Mierau (2017) utilize a similar identification strategy as Rigterink (2021), but study the impact of leadership targeting in the Israeli-Palestinian case in addition to Pakistan. They find that leadership targeting increases the share of attacks against non-government and non-military targets, but has no significant effect on the total number of attacks. Overall, then, these studies find evidence supporting the existence of problems of control, but show more mixed empirical support for the contention that drone programs increase terrorism in the aggregate.

The second main argument made by drone pessimists relates to civilian "blowback" or "backlash." The logic of this argument is that drone strikes cause blowback among the civilian population by killing or psychologically terrifying noncombatants, violating countries' sovereignty, etc. (Boyle 2013; Cronin 2013; Christia et al. 2021). Blowback from civilians caused by drones could increase terrorism through two primary mechanisms. First, blowback could motivate civilians to directly aid terrorist groups by joining them, providing material support to them, or even carrying out lone-wolf attacks. For example, Faisal Shahzad, who attempted to set off a bomb in Times Square in 2010, claimed U.S. drone strikes in Pakistan were one factor motivating him to carry out the attack. Second, blowback could prompt outraged civilians to indirectly aid terrorist groups by refusing to provide the intelligence necessary to combat them.

Nonetheless, there is little direct systematic evidence for the blowback hypothesis when it comes to armed UAV programs. Shah (2018) conducts in-depth interviews with residents of North Waziristan, terrorism experts, and Pakistani counter-terrorism officials and finds that U.S. drone strikes in Pakistan do *not* cause significant blowback among

[2] The analysis focuses only on the impact of strikes in Pakistan and only on strikes targeting leaders, of which there are 45 in the main specification.

civilians or hugely increase militant groups' recruitment. For example, 71% of the North Waziristan residents he interviewed disagreed that drone strikes created militants, and over 90% of the counter-terrorism officials Shah consulted declined to endorse the blowback hypothesis. Similarly, Loidolt (2022) reviews declassified documents recovered from the operation that killed Osama Bin Laden and finds no evidence that al-Qaeda leaders themselves believed drone strikes increased their popular support. If anything, the evidence suggests al-Qaeda believed UAV strikes undermined it. Lastly, counter to the logic of the blowback thesis, Rigterink (2021) finds no evidence that drone strikes hitting only civilians, or drone strikes hitting many civilians, are associated with an increase in terrorist attacks.[3]

The third principal argument concerns signaling and revenge. With respect to signaling, terrorist organizations may have incentives to increase the number of attacks in the wake of drone strikes or the initiation of a drone program in order to signal their resolve and capabilities (Gartzke and Walsh 2022). As for revenge, drone strikes could also increase terrorism by causing blowback among militants themselves, inciting them to seek revenge against either civilians they believe are informants or directly against the government that conducted the strike (Jaeger and Siddique 2018).

There is some evidence for the signaling and revenge argument. Jaeger and Siddique (2018) find that in the first week following an American drone strike in Pakistan, there was an increase in terrorist violence. They attribute this to a "vengeance effect." However, this finding is not robust to alternative specifications and drone strikes are associated with *less* terrorism in the second week following a UAV strike.

In summary, the arguments of drone pessimists suggest the following hypothesis should hold, on average:

$H_{Pessimists}$: Armed UAV programs increase terrorism.

[3] Gartzke and Walsh (2022) find a similar null effect in their study on U.S. drone strikes in Pakistan.

Drone Optimists

From the perspective of drone optimists, armed UAV programs bolster counterterrorism efforts. There are two principal arguments made by those in this camp: (1) disruption and (2) degradation. The mechanisms for both involve the way UAV operations can undermine a terrorist group's capacity.

The first argument involves "disruption," also known as "anticipatory effects" (Perlez and Shah 2010; Johnston and Sarbahi 2016; Mir 2018; Mir and Moore 2019). Disruption reduces terrorism by increasing the security risk to militants and thus making it harder for them to operate. For example, fear of drone strikes and the intelligence drone surveillance operations gather can cause terrorists to restrict their movements, reduce their communications, close their training camps, and become more distrustful of allies and potential recruits. With these limitations placed on their ability to operate—and especially operate *openly*—terrorist groups may have a reduced capacity to carry out attacks. Relevant for our purposes is that the anticipatory mechanism can have an effect whether or not a group or individual is actually or successfully targeted (Mir 2018, 54; Mir and Moore 2019, 848-851).[4] Consequently, this mechanism could still operate for states in our sample that have acquired armed UAVs but not conducted any or many strikes.

There is significant micro-level evidence for arguments related to disruption. Quantitatively, Mir and Moore (2019) analyze the impact of the American drone program in Pakistan. They do so by comparing areas within the "flight box" over Waziristan—where the U.S. was authorized to operate UAVs by the Pakistani government—to other areas in FATA not included in the box before and after the start of the U.S. drone program. This bears some similarity to our analysis, as Mir and Moore (2019) examine the impact of a UAV *program* in the aggregate, not just the impact of *individual* strikes. Consistent with the primary argument of drone optimists, they find that the United States' drone program was associated with a decline in aggregate levels of terrorism. Additionally, Mir and Moore (2019) present evidence that the disruption mechanism drives their results.

[4] Of course, the more frequently and successfully a group is targeted, the more likely disruption is to occur.

They find that almost 75% of the reduction in terrorism is associated with the period of the drone program *without* any strikes. This finding increases the plausibility that armed UAV acquisition alone could affect aggregate levels of terrorism.

There is also qualitative evidence for the disruption argument. In a letter to Bin Laden, al-Qaeda leader Atiyah Abd al-Rahman (who eventually became al-Qaeda's second-ranking figure and operational planner) suggested "stopping many of the operations so we can move around less, and be less exposed to strikes" (Mir 2018, 73). He also discussed how "the bombings have exhausted us" (Loidolt 2022). Bin Laden himself lamented the disruption caused by UAVs. In one letter to al-Rahman, Bin Laden said,

> "I had mentioned in several previous messages...the importance of the exit from Waziristan of the brother leaders, especially the ones that have media exposure. I stress this matter to you and that you choose distant locations to which to move them, away from aircraft, photography and bombardment while taking all security precautions" (Benson 2012).

Bin Laden later warned al-Rahman about militants traveling in cars and suggested they "should move only when the clouds are heavy" (Benson 2012). With respect to communication, Bin Laden advised, "Remind your deputies that all communication with others should be done through letters" (Benson 2012). Clearly, these restrictions make it more difficult for terrorists to plan and carry out attacks.

There is also evidence for the disruptive effects of armed drones outside of the U.S. context. Turkey's domestically-developed Bayraktar TB2 armed UAV has logged over 300,000 flight hours in operations primarily targeting members of the Kurdistan Workers' Party (PKK). These operations have made armed drones a constant presence for PKK members, reportedly incentivizing them not to gather or move in large groups (Farooq 2019).

The second main argument made by drone optimists involves "degradation," also known as "kinetic effects" (Johnston and Sarbahi 2016; Mir 2018; Mir and Moore 2019). Degradation reduces terrorism by physically removing leaders and key operators from the battlefield and damaging a terrorist group's infrastructure. Highly skilled individuals that can speak multiple languages, build bombs, fly planes, etc. are critical to group success, and previous research shows that many terrorists are well-educated and come from relatively affluent backgrounds (Krueger and Maleckova 2003; Bueno de Mesquita 2005).

There is evidence to support the degradation argument. Johnston and Sarbahi (2016) analyze how drone strikes affect weekly levels of terrorism by leveraging a range of quasi-random factors that influence the week-to-week timing of UAV strikes, such as weather, the availability of drones to conduct strikes, and bureaucratic factors like the availability of relevant officials to approve a strike. Supporting the drone optimist school of thought, they find that strikes are associated with less terrorism in the short-term. Johnston and Sarbahi (2016) also find evidence for the degradation argument specifically, as strikes that kill high value targets are more effective than those that do not.

Turkish armed UAVs have also significantly degraded the PKK. In one major operation that was (oddly) code-named Olive Branch, Turkish armed drones flew almost 400 sorties, logged almost 5,000 flight hours, and directly (through strikes) or indirectly (through target acquisition) killed over 1,000 alleged PKK militants (Özçelik 2018). Over the last several years, Turkish armed UAVs have collectively killed thousands of supposed militants, including dozens of PKK leaders.

In summary, the arguments of drone optimists suggest the following hypothesis should hold:

$H_{Optimists}$: Armed UAV programs decrease terrorism.

Research Design

To test the above hypotheses, we compile a time-series cross-sectional dataset that contains information about the 18 countries that obtained armed drones during the period from 2001 to 2019. The unit of observation is the country-year. We compare terrorism rates in the pre- and post-acquisition periods among the universe of countries that acquired armed drones. As described below, this within-unit strategy provides variation in the independent variable of interest—armed UAVs—and allows us to make relatively controlled comparisons within a critical sample of countries.

Explanatory Variables

We use a new dataset that measures *all* states' armed UAV programs from 2001 through 2019. Based on our dataset, we construct three dichotomous variables: *Armed UAV Possession* (does a state have armed drones?), *UAV Strike* (has a state fired munitions from drones?),[5] and *Armed UAV Pursuit* (has a state pursued armed drones?). Despite the normal challenges of accurately assessing national military capabilities, we obtained detailed information about armed UAV programs from media reports and from trade publications like *Janes*, which specializes in open-source military intelligence, as well as think tanks like the *Stockholm International Peace Research Institute* and organizations like *The Center for the Study of the Drone at Bard College*. Even countries that might be thought of as secretive when it comes to military technology, like Iran and China, often like to flaunt their UAV technology at airshows and parades, as well as on state-owned television, making it easier to accurately code this variable. All independent variables are lagged one year to reduce concerns about potential endogeneity. Table 2 summarizes the main explanatory variables and we provide all of the sources used to construct these variables in the appendix.

Dependent Variables

Our measure of terrorism comes from the Global Terrorism Database (2019).[6] We construct two principal variables in order to test $H_{Pessimists}$ and $H_{Optimists}$: *Terrorist Attacks* and *Terrorist Deaths*. The former measures the number of terrorist attacks against a country's citizens in a given year (domestically or internationally), and the latter measures the number of people killed in terrorist attacks in a given year (domestically or internationally). In other words, our main measure of terrorism includes both domestic

[5] Future research should evaluate how the frequency of strikes impacts terrorism.

[6] See pages 11-12 of the GTD codebook for an explanation of how they define terrorism.

Table 2: Year of Armed UAV Acquisition, Strike, & Pursuit

Country	Armed UAV Acquisition	UAV Strike	Armed UAV Pursuit
United States	2001	2001	1999
Israel	2004	2004	1994
United Kingdom	2008	2008	2007
China	2013	-	2008
Iran	2013	2016	2010
United Arab Emirates	2013	2016	2011
Nigeria	2014	2016	2014
South Africa	2014	-	2010
Egypt	2015	2016	2015
Iraq	2015	2015	2014
Pakistan	2015	2015	2015
Saudi Arabia	2015	2016	2014
Uzbekistan	2015	-	2013
Jordan	2016	-	2015
Kazakhstan	2016	-	2015
Myanmar	2016	-	2013
Turkey	2016	2016	2004
Turkmenistan	2016	-	2015

and transnational attacks directed against a country's citizens.[7]

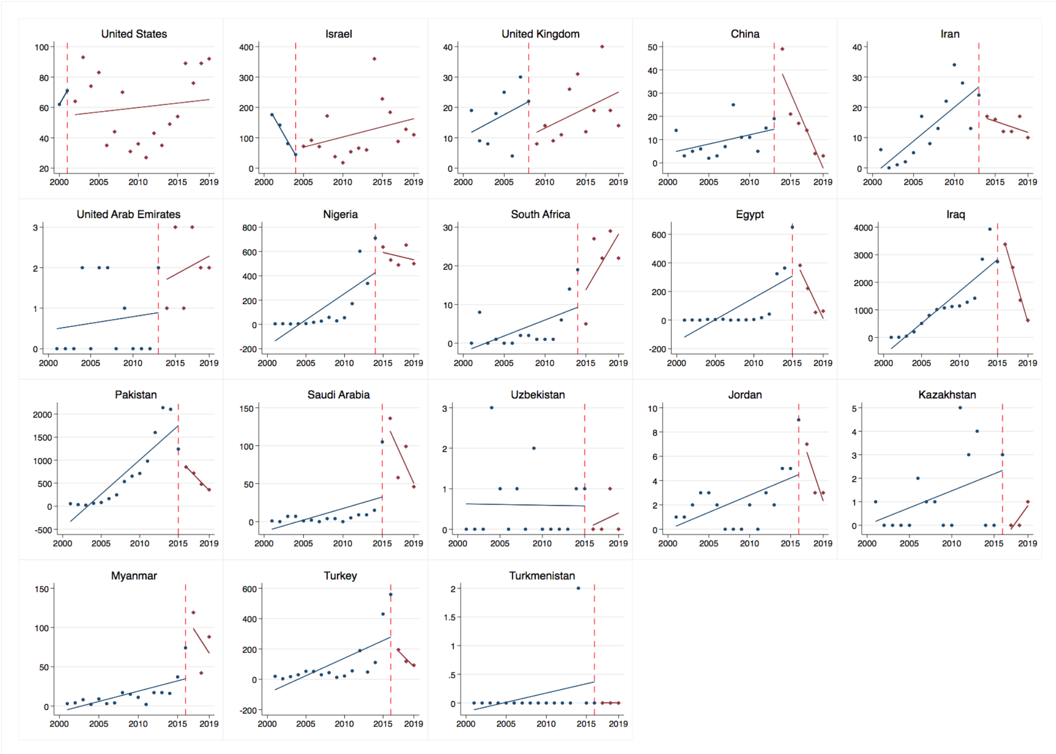
Figure 1 displays our measure of terrorist attacks over time by country with linear trends fit before and after countries acquired armed UAVs (Mir and Moore 2019, 849-851). In almost three-quarters of countries, the number of terrorist attacks appear grow more slowly or even decline after armed UAV acquisition, providing some initial descriptive evidence in support of $H_{Optimists}$.

Control Variables

One challenge with identifying a causal relationship between armed drones and terrorism is that there may be other factors correlated with both armed drone adoption

[7]Note that some countries primarily utilize armed drones domestically, some countries use armed drones mostly internationally, and other countries do both. Even if armed drones employed domestically only have a significant impact on domestic terrorism and armed drones employed internationally only have a significant effect on transnational terrorism, the relatively broad measure of terrorism we utilize in our main models should still capture these effects and, if anything, make our analysis a harder test for finding significant effects at all. Furthermore, while armed drones used internationally, for example, cannot have kinetic effects on domestic terrorism, they could still potentially impact domestic terrorism via anticipatory effects.

Figure 1: Terrorist Attacks Over Time By Country



Note: These graphs depict the number of terrorist attacks in each year with linear trends fit before and after countries acquired armed UAVs.

and terrorism, which, if not controlled for, could lead to omitted variables bias. To address this issue, we include a comprehensive set of control variables, which are also utilized in other studies on terrorism, increasing the comparability of our results to other research (e.g., Li 2005; Piazza 2008; Wilson and Piazza 2013; Gaibulloev, Piazza, and Sandler 2017; Mahmood and Jetter 2020):

- GDP per Capita: The log of a state's GDP per capita in constant 2010 dollars, according to the World Bank. This variable has been shown to impact both UAV acquisition and terrorism (Li 2005; Fuhrmann and Horowitz 2017).

- Regime Type: We employ the Polity IV Project's 21-point indicator, where higher values mean a country is more democratic. Prior research finds a relationship between regime type and armed drone acquisition (Horowitz, Schwartz, and Fuhrmann 2022), as well as regime type and terrorism (e.g., Gaibulloev, Piazza, and Sandler 2017).

- Civil War: A binary variable indicating whether a country is experiencing civil war according to the UCDP/PRIO dataset (1,000 battle-related deaths in a given year). Civil war can both incentivize states to procure drones and lead to increased levels of terrorism (Bove and Böhmelt 2016).

- Failed State: Following Wilson and Piazza (2013) and Bove and Böhmelt (2016), we control for the extent to which a country is a failed state. This factor can both increase demand for armed UAVs and impact terrorism. Data for this variable comes from the Political Instability Task Force (2018), with higher values indicating a country is in more dire straits.

- Human Rights Violations: Some countries combat terrorism by restricting civil liberties, including employing more brutal interrogation techniques. Prior research also demonstrates that human rights violations are associated with armed drone acquisition (Horowitz, Schwartz, and Fuhrmann 2022). To control for this factor, we include a variable from the Political Terror Scale that measures violations of human rights by agents of a state (Gibney et al. 2017).

- Counter-Terrorism Aid: Another strategy countries might adopt to combat terrorism is to seek counter-terrorism aid from the United States. Additionally, a relationship with the U.S. can impact the probability of armed drone acquisition (Horowitz, Schwartz, and Fuhrmann 2022). Using data from the Security Assistance Monitor (2019), we construct a variable that includes all U.S. aid specifically earmarked for counter-terrorism in constant 2015 dollars.

- Terrorism in Neighboring Countries: Terrorism in neighboring countries could both motivate states to acquire armed UAVs and affect terrorism directed at them (Midlarsky, Crenshaw, and Yoshida 1980). We therefore include a spatial lag variable in our models, which measures the average number of terrorist attacks in a country's neighbors.[8]

[8] See Wimpy, Whitten, and Williams (2021) for an overview of why this kind of "spatial-x" specification is often preferable to a spatial autoregressive model.

Estimation Strategy

As is common in the literature on drones and terrorism, we adopt a difference-in-differences-like (DiD) design (Johnston and Sarbahi 2016; Mir and Moore 2019). We operationalize this estimation strategy in two steps. First, we only include countries in our analysis that eventually acquired armed UAVs and exclude "never-treated" countries (Callaway and Sant'Anna 2021, 205; Sun and Abraham 2021, 178). We do so because states that have acquired armed drones differ from those that have not in ways that cannot be easily observed or accounted for in a statistical analysis. For example, armed drone adopters differ from non-adopters when it comes to their vulnerability to terrorism; the former experience approximately five times more terrorist attacks per year on average than the latter.[9] Therefore, comparing drone adopters like Nigeria and Egypt to non-adopters like Mexico and Norway may result in apples-to-oranges comparisons. Second, we include country and year fixed effects.[10]

In its simplest form, a DiD estimate in this context is the change in terrorism for *Country A* after they acquire armed drones compared to before they acquired armed drones, minus the change in terrorism for *Country B*, whose treatment status did not change in the examined time period. For example, since Iran acquires armed drones in 2013 and Iraq acquires them in 2015, one quantity of interest our DiD estimator could calculate (in a simplified form) is the following:

$$Effect = (Terrorism^{Iran}_{2013} - Terrorism^{Iran}_{2012}) - (Terrorism^{Iraq}_{2013} - Terrorism^{Iraq}_{2012})$$

By isolating the within-country variation for both Iran and Iraq, the estimator accounts for differences between countries that are constant over time, such as geography.

[9] Unfortunately, this makes synthetic control and matching methods infeasible because there are very few non-adopters that have similar pre-treatment levels of terrorism as adopters.

[10] Given that our dependent variable is an overdispered count variable, we primarily employ negative binomial models, which are used frequently in studies on terrorism in conjunction with TWFE (e.g., Daxecker 2017; Gaibulloev, Piazza, and Sandler 2017; Mahmood and Jetter 2020). Our main specifications also include a lagged dependent variable given that terrorism in year t is highly correlated with terrorism in year t − 1.

By comparing within-country variation for both Iran and Iraq for 2013 versus 2012, the estimator accounts for *common* time shocks. Since our analysis involves more than two countries and the countries acquire armed drones at different points in time, the calculation of our DiD estimate is more complicated: it is a weighted average of all possible two-country/two-year comparisons, such as the example shown above (Goodman-Bacon 2021).

Compared to a simple regression that included all countries in the world and no fixed effects, we believe our approach yields a more credible estimate of the effect of armed drones on terrorism for two reasons. First, we do not compare armed drone adopters to non-adopters given that they have significantly different underlying risks of terrorism. Second, we believe it is prudent to control for differences between countries—such a geography—that can have a significant impact on terrorism. While there are, of course, some differences within countries pre- and post-drone acquisition, these differences are almost certainly less stark than between countries. Utilizing this type of design somewhat limits the amount of variation we are able to exploit, but it still provides variation in the independent variable of interest—armed UAVs—and allows us to make relatively controlled comparisons within a sample of many more countries than prior research. Lee et al. (forthcoming) adopt a similar strategy for similar reasons in order to analyze the impact nuclear weapons (a military technology like UAVs) has on low-level conflict (a form of political violence like terrorism).

In an attempt to further control for other counter-terrorism strategies states may adopt besides armed UAVs, we also exploit the gap in time between when states pursue armed drones and when they actually acquire them. Countries that are pursuing armed drones are likely taking other steps to combat terrorism, and thus comparing the period after a state acquires to the period when a state is pursuing helps isolate the effect of armed UAV acquisition from those other counter-terrorism efforts. The variable we construct for this test—*Acquisition Delay*—is missing when a country has not pursued or acquired armed UAVs (and so these years drop), equals 0 when a country has pursued but not acquired, and equals 1 when a country acquired armed UAVs.

Finally, while the inclusion of TWFE is the most common approach to estimating a DiD model, recent research establishes that treatment effect heterogeneity can cause these models to yield biased estimates, potentially even causing the direction of the principal effect to be reversed (Imai and Kim 2020; Goodman-Bacon 2021). The core problem relates to the comparison group (i.e., Iraq in the above example). Iraq is a "good" comparison group in the above illustration because it is not-yet-treated in 2013. However, in some cases, the conventional DiD estimator will use countries that have already been treated in the past as comparison groups. For instance, the United Kingdom could be used as a comparison group even though it acquired armed UAVs in 2008 while Iran did so in 2013. Since the United Kingdom's treatment status did not change between 2012 and 2013, it could be a valid comparison group *assuming there is no treatment effect heterogeneity.* But if that assumption is violated, then problems can emerge. Imagine there is treatment effect heterogeneity such that armed drones actually *increase terrorism* and this effect is becoming stronger over time. In that case, the increase in terrorism for Iran in 2013 relative to 2012 might be smaller than the increase in terrorism for the United Kingdom in 2013 relative to 2012. Very problematically, the overall effect from this specific comparison will be negative, suggesting that armed drones decrease terrorism when, in this hypothetical, they actually do the opposite. We take two steps to address this potential issue. First, we utilize the Callaway and Sant'Anna (2021) estimator, which explicitly accounts for this possibility by modeling treatment effect heterogeneity and restricting the analysis to comparisons between treated and not-yet-treated countries. Second, we decompose our DiD estimate in order to check whether comparisons between already-treated countries are driving the direction of our findings (Goodman-Bacon 2021). This analysis demonstrates that they are not and, if anything, our primary model is a conservative estimate of the impact of armed UAVs on terrorism.

To be clear, our observational, cross-national approach does not generate the causal leverage of micro-level research. However, the multitude of strategies we employ reduce barriers to inference and enhance the credibility of our research design. The aforementioned benefits of our macro-level analysis—especially determining whether patterns generalize beyond the U.S. context—also mean that our study can usefully complement prior research.

Main Results

Table 3 contains the results from six statistical models. All models show a *negative* and statistically significant relationship between armed drones and terrorism, supporting $H_{Optimist}$ and the view that armed drones reduce terrorism. Models 1 through 3 use *Terrorist Attacks* as the dependent variable. Our primary specification—Model 1—includes country fixed effects, year fixed effects, and a lagged dependent variable. It demonstrates that acquiring armed drones is associated with a statistically significant decline in terrorism. In Model 2, we show that this result holds when we leverage the gap in time between when states pursue armed UAVs and when they acquire them in order to better isolate the impact of armed drone possession. Model 3 demonstrates that the negative relationship between armed drones and terrorism holds—and the size of the effect increases—when a variable measuring whether countries have actually fired munitions from drones in combat is used. This result is not surprising given that, compared to just possessing armed UAVs, conducting drone strikes could actually degrade terrorist groups in addition to disrupting them. In Model 4, we show our principal result is robust to the use of an alternative dependent variable: *Terrorist Deaths*. Model 5 demonstrates this finding is also robust to the use of a log-linear model. Finally, in Model 6 we utilize the Callaway and Sant'Anna (2021) estimator, which demonstrates that our core result holds when taking into account the possibility of heterogeneous treatment effects and the associated bias it can produce in simple TWFE models.[11]

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[11] This model also finds no significant evidence for pre-treatment trends, providing evidence in support of the parallel trends assumption that is critical for DiD models. We do not include additional covariates in Model 6 because it is a much more complicated model than the simple TWFE model. Given the relatively small number of observations in our sample, this means the Callaway and Sant'Anna (2021) estimator cannot provide an estimate when all of our control variables are included. Nevertheless, the core finding holds when a subset of control variables are included, such as GDP per capita and regime type. Due to the complexity of this model, we start the analysis in 1998 instead of 2001 to increase statistical power. The results for *UAV Strike* also hold when employing this estimator.

Table 3: Effect of an Armed Drone Program on Terrorism

	(1) Attacks	(2) Attacks	(3) Attacks	(4) Deaths	(5) Attacks	(6) Attacks
Armed UAV Possession	-0.4429***			-1.3011***	-0.3364**	-0.8805***
	(0.1710)			(0.3103)	(0.1485)	(0.3408)
Acquisition Delay		-0.3473**				
		(0.1626)				
UAV Strike			-0.6036***			
			(0.1913)			
GDP per Capita	-0.1280	-1.1691	-0.3419	0.7292	-0.4239	
	(0.3349)	(1.0048)	(0.3561)	(0.4928)	(0.5110)	
Level of Democracy	0.0621***	0.0774***	0.0529***	0.0331	0.0444	
	(0.0197)	(0.0284)	(0.0185)	(0.0286)	(0.0413)	
Civil War	-0.0359	0.1949	-0.0837	-0.2210	0.0010	
	(0.2800)	(0.2594)	(0.2641)	(0.4230)	(0.3619)	
Failed State	0.5477***	0.4877***	0.5754***	0.6538***	0.6585***	
	(0.0892)	(0.1311)	(0.0884)	(0.1284)	(0.1150)	
Political Terror Scale	0.1551	0.3851*	0.1160	0.0364	0.0480	
	(0.1336)	(0.2277)	(0.1343)	(0.2160)	(0.1519)	
Counter-Terrorism Aid	0.0005	-0.0332**	-0.0032	0.0012	-0.0086	
	(0.0121)	(0.0150)	(0.0122)	(0.0201)	(0.0116)	
Terrorism in Neighboring Countries	-0.0004	-0.0006	-0.0002	-0.0022***	-0.0002	
	(0.0005)	(0.0012)	(0.0005)	(0.0008)	(0.0009)	
Constant	4.2826	14.0650	6.8314*	-2.4565	5.0096	
	(3.4964)	(10.4074)	(3.7373)	(5.1452)	(4.3107)	
Model	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	OLS	Callaway & Sant'Anna
Country Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Lagged DV	✓	✓	✓	✓	✓	×
Logged DV	×	×	×	×	✓	✓
Observations	335	119	335	335	335	342

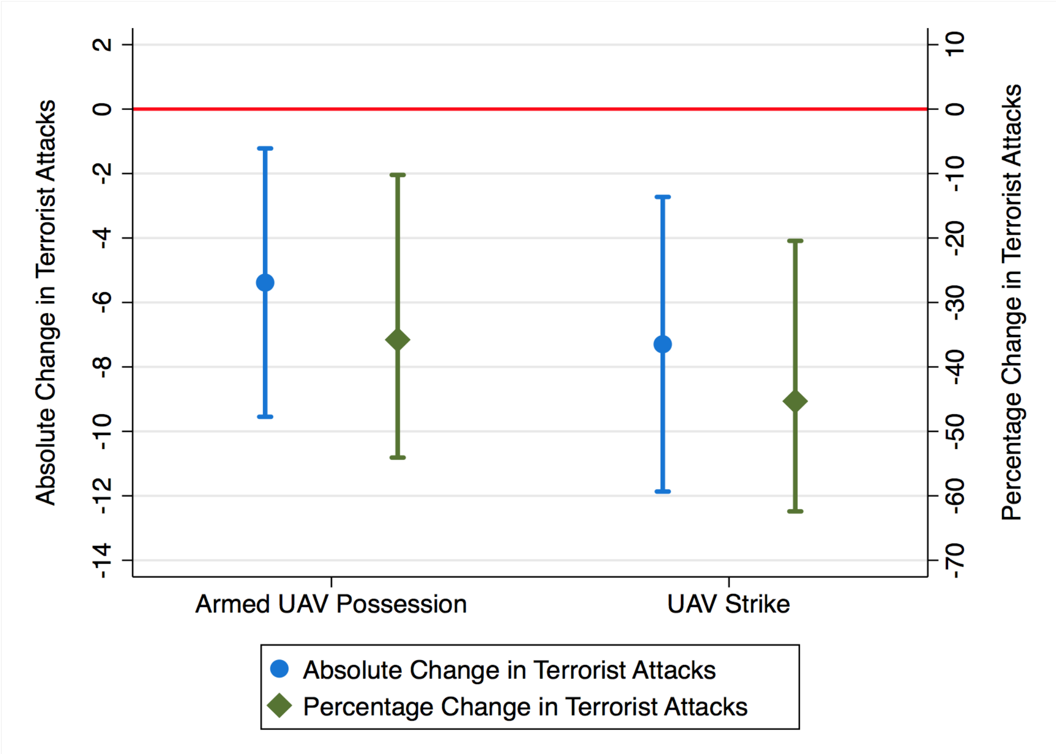
Notes: Standard errors in parentheses. *p<0.10; **p< 0.05; ***p<0.01

Figure 2 and Figure 3 demonstrate that our results are substantively significant as well. Possessing armed UAVs is associated with about 5.5 fewer terrorist attacks and 31 fewer deaths from terrorism per year. This equates to a 35% decrease in terrorist attacks and 73% decrease in deaths from terrorism per year.[12] Unsurprisingly, having conducted at least one drone strike is associated with even larger effects: approximately 7.25 fewer terrorist attacks and 34 fewer deaths per year. This equates to a 45% decrease in terrorist attacks and 77% decrease in deaths from terrorism per year.

Compared to other significant variables in our models and additional drivers of terrorism found in prior studies, these effects are relatively large. For example, using estimates from Model 1, a one-unit increase in *Level of Democracy* (Polity) is associated

[12] These statistics are calculated using incidence rate ratios.

Figure 2: Substantive Effects of Armed Drones on Terrorist Attacks

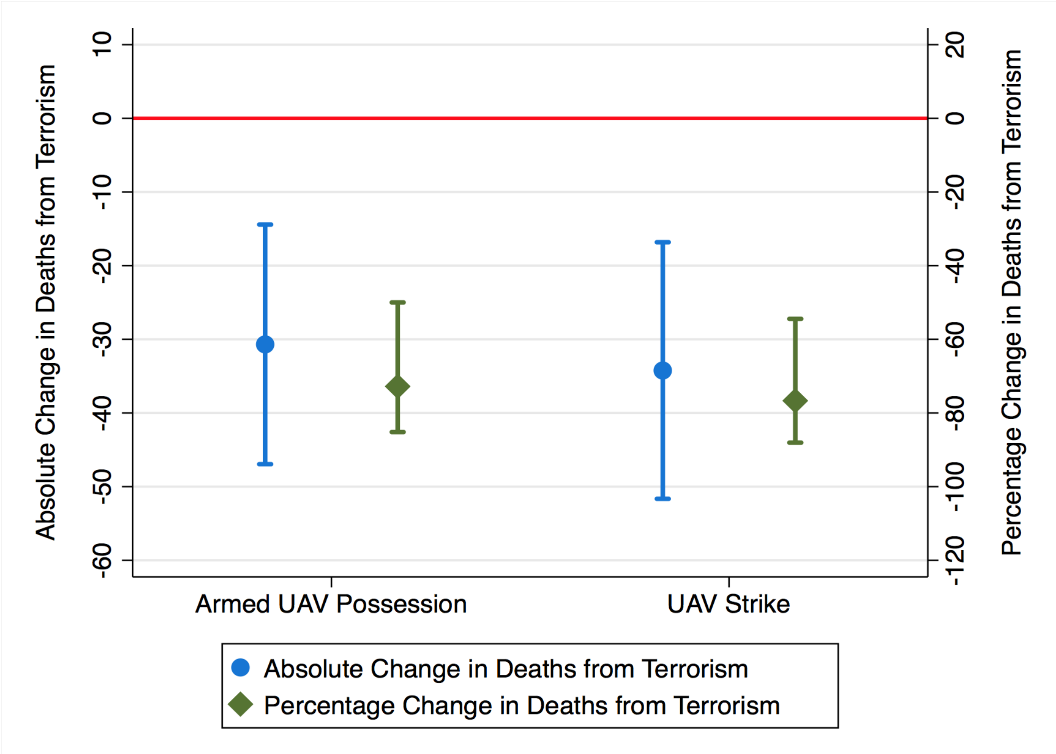


Note: Bars indicate 95% confidence intervals. Armed UAV Possession is derived from Model 1 and UAV Strike from Model 3.

with about 0.75 more terrorist attacks, and a one-unit increase in *Failed State* is associated with an increase of around 6.5 attacks. Relative to previous studies, the substantive impact of an armed UAVs program is also larger than the impact of a one-unit increase in log population (Daxecker 2017; Piazza 2020); a one-unit increase in log GDP per capita (Piazza 2020); an additional internal armed conflict (Piazza 2020); an increase in migrant inflows (Böhmelt and Bove 2020); an approaching election (Aksoy 2014); a one-unit increase in the log number of scarring torture allegations (Daxecker 2017); and a 20 percentage point increase in a country's male-female ratio (Younas and Sandler 2017).

The substantive effects also make sense relative to previous micro-level research on the impact of the American drone program in Pakistan. For instance, Mir and Moore (2019) find the U.S. drone program is associated with 9 to 13 fewer attacks per *month* and 51 to 86 fewer casualties per *month*. This implies the U.S. drone program has a larger *annual* impact than we find on average among all armed drone adopters, which is logical for two reasons. First, the American UAV program involves more sorties and strikes than

Figure 3: Substantive Effects of Armed Drones on Terrorist Deaths



Note: Bars indicate 95% confidence intervals. Armed UAV Possession is derived from Model 4 and UAV Strike from a model identical to Model 3 except with *Terrorist Deaths* as the dependent variable.

the average UAV program in other countries. Second, U.S. drone technology and support systems are much more advanced than the average country's, giving Washington greater monitoring and strike capabilities.

Disaggregating Terrorism into Domestic and Transnational Attacks

Given that the impact of armed UAVs could differ for domestic versus transnational attacks, in Table 4 we disaggregate terrorism into these two categories using a method developed by Enders, Sandler, and Gaibulloev (2011).[13] Starting with Models 1-4, we find that *Armed UAV Possession* and *UAV Strike* are both significantly associated with fewer domestic *and* transnational terrorist attacks. For Models 5-8, we code two additional variables: *Domestic UAV Strike* and *International UAV Strike*. The for-

[13]We start this analysis in 1998 to maximize statistical power.

mer measures whether a country has conducted a drone strike domestically, and the latter measures whether they have conducted a drone strike internationally. We code these supplemental variables because the geography of drone usage is likely to change the type of terrorism that drones impact. In accordance with this logic, Model 5 shows that there is a significant relationship between domestic drone strikes and domestic terrorism, but Model 6 shows there is not a statistically significant relationship between domestic drone strikes and international terrorism. Although domestic drone strikes could impact transnational terrorism via anticipation effects, the relationship between domestic drone strikes and domestic terrorism is more direct. Models 7 and 8 shows that international drone strikes significantly impact both transnational and domestic terrorist attacks. However, comparing Models 5 and 7 illustrates that the substantive impact of domestic drone strikes on domestic terrorist attacks is greater than the substantive impact of international drone strikes on domestic terrorist attacks. Overall, these results demonstrate that geography is an important factor to consider when evaluating the impact of armed UAVs—or, more broadly, any counter-terrorism efforts—on terrorism (Gartzke and Walsh 2022).

Table 4: Disaggregating Terrorism into Domestic and Transnational Attacks

	(1) Domestic Attacks	(2) Transnational Attacks	(3) Domestic Attacks	(4) Transnational Attacks	(5) Domestic Attacks	(6) Transnational Attacks	(7) Domestic Attacks	(8) Transnational Attacks
Armed UAV Possession	-0.6561***	-0.3915**						
	(0.2203)	(0.1890)						
UAV Strike			-0.7296***	-0.4660***				
			(0.2272)	(0.1787)				
Domestic UAV Strike					-0.8888**	-0.1230		
					(0.3532)	(0.2631)		
International UAV Strike							-0.4984*	-0.5385***
							(0.2849)	(0.2033)
GDP per Capita	-0.4705	0.5184*	-0.7243*	0.3451	-0.4023	0.5902**	-0.5945	0.3916
	(0.3846)	(0.2900)	(0.3928)	(0.3117)	(0.3819)	(0.2898)	(0.3917)	(0.3031)
Level of Democracy	0.0581***	0.0307	0.0543***	0.0284	0.0499**	0.0270	0.0497**	0.0187
	(0.0212)	(0.0188)	(0.0196)	(0.0179)	(0.0201)	(0.0188)	(0.0205)	(0.0186)
Civil War	0.0882	-0.0899	-0.0293	-0.1357	-0.0988	-0.1039	0.1288	0.0159
	(0.2913)	(0.2315)	(0.2840)	(0.2425)	(0.3020)	(0.2660)	(0.2926)	(0.2240)
Failed State	0.5023***	0.3593***	0.5516***	0.3910***	0.6028***	0.3799***	0.4968***	0.3478***
	(0.1105)	(0.0943)	(0.1080)	(0.0942)	(0.1166)	(0.1006)	(0.1078)	(0.0927)
Political Terror Scale	-0.0896	0.0019	-0.0893	-0.0246	-0.1733	-0.0344	-0.0956	-0.0020
	(0.1582)	(0.1014)	(0.1599)	(0.0984)	(0.1571)	(0.0990)	(0.1674)	(0.0995)
NADR Aid	0.0218	0.0130	0.0099	0.0065	0.0170	0.0138	0.0168	0.0094
	(0.0166)	(0.0120)	(0.0166)	(0.0121)	(0.0169)	(0.0122)	(0.0162)	(0.0118)
Terrorism in Neighboring Countries	-0.0006	0.0002	-0.0005	0.0003	-0.0003	0.0004	-0.0005	0.0001
	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0005)
Constant	6.6884*	-3.2700	9.4463**	-1.3446	5.9160	-4.1167	8.0624*	-1.7236
	(4.0498)	(3.1282)	(4.1371)	(3.3532)	(4.0231)	(3.1098)	(4.1320)	(3.2766)
Model	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial
Country Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Lagged DV	✓	✓	✓	✓	✓	✓	✓	✓
Observations	389	389	389	389	389	389	389	389

Notes: Standard errors in parentheses. *p<0.10; **p< 0.05; ***p<0.01

Robustness

We conduct a number of tests (further detailed in the appendix) in order to assess the robustness of our main findings:

- We decompose our DiD estimate in order to check whether comparisons between already-treated countries are causing the main coefficient to have the wrong sign (Goodman-Bacon 2021). Our analysis suggests this is not the case. Comparing treated countries to not-yet-treated countries (the "good" comparison) yields a negative effect of armed UAVs on terrorism, and this effect is stronger (i.e., more negative) than the potentially "bad" comparison between already-treated countries. Overall, then, our baseline model provides a conservative estimate of the impact of armed UAVs on terrorism.

- We iteratively drop countries to show that there is not a single state driving the findings. We also demonstrate the results hold when dropping *both* the U.S. and Israel, two of the most capable and active drone operators in the world.

- We utilize an additional strategy to increase the comparability of the pre- and post-acquisition periods: limiting the analysis to the 1, 2, or 3 years before and after a country acquired armed UAVs. By narrowing the time frame under study, we can better isolate the impact of obtaining armed drones.

- We control for a state's military spending as a percentage of GDP and a measure of state capacity developed by Hendrix and Young (2014).

- We use alternative specifications of our primary control variables (e.g., V-Dem instead of Polity).

- We demonstrate that our results are robust to the use of an alternative dependent variable: *Suicide Attacks* (Pape, Rivas, and Chinchilla 2021). Although not all suicide attacks can be categorized as terrorism, in practice they are highly correlated ($\rho \approx 0.73$ in our sample).

- Given the challenges associated with interpreting TWFE models (Imai and Kim 2020; Kropko and Kubinec 2020), we show that our results hold when only country fixed effects are included. Taken together, these tests lend confidence to our core finding.

Probing Potential Causal Mechanisms

Having found evidence supporting the primary hypothesis of drone optimists, we turn to analyzing which causal mechanisms from extant theories might best explain our main results. In accordance with the negative relationship we uncover between armed UAVs and terrorism, we find stronger evidence for the impact of mechanisms posited by drone optimists (such as disruption and degradation) than the mechanisms suggested by drone pessimists (like problems of control and signaling).

Terrorist Group Capacity: Disruption and Degradation

To analyze whether armed UAVs disrupt terrorist groups, we drop a country's observations after they conduct their first UAV strike and drop countries that conducted a strike the year they acquired armed UAVs.[14] This allows us to isolate the impact of armed drone acquisition from armed drone strikes. Since armed UAV acquisition cannot by itself lead to degradation effects if no strikes are conducted, finding a negative relationship between this variable and the number of terrorist attacks would indicate a strong likelihood of armed UAVs playing a disruptive role. Model 1 in Table 5 illustrates that this negative relationship is supported, which provides evidence for disruption as a causal mechanism explaining the relationship between UAVs and terrorism.[15]

We also find additional evidence that our main results are driven by a reduction in the capacity of terrorist groups. Per Rigterink (2021), if armed UAVs undermine group capacity, then they should reduce the success rate and death rate of terrorist attacks.

[14] Mir and Moore (2019) adopt a similar strategy.

[15] Unfortunately, it is more difficult to empirically isolate the impact that degradation has independent of disruption, and thus we do not attempt to do so.

After all, if drone programs erode a terrorist group's capacity, then it is less likely the attacks they do conduct will achieve their objectives. We test these contentions in Models 2 through 5 in Table 5 and find that *Armed UAV Possession* and *UAV Strike* are both associated with lower success and death rates.[16]

Table 5: Causal Mechanisms: Disruption and Degradation

	(1) Attacks	(2) Success Rate	(3) Death Rate	(4) Success Rate	(5) Death Rate
Armed UAV Possession (Excluding Strike)	-0.8061***				
	(0.2960)				
Armed UAV Possession		-0.0403*	-0.5299***		
		(0.0242)	(0.1921)		
UAV Strike				-0.0604**	-0.5957***
				(0.0270)	(0.2133)
GDP per Capita	-1.0713*	0.2047***	0.7511**	0.1453**	0.5188
	(0.5523)	(0.0659)	(0.3261)	(0.0651)	(0.3321)
Level of Democracy	0.0716*	-0.0006	-0.0280*	-0.0012	-0.0355**
	(0.0412)	(0.0016)	(0.0143)	(0.0016)	(0.0145)
Civil War	0.0000	0.0292	0.0033	0.0265	0.0300
	(.)	(0.0235)	(0.1962)	(0.0234)	(0.1945)
Failed State	0.4359***	-0.0053	0.1606**	0.0003	0.1975***
	(0.1633)	(0.0081)	(0.0636)	(0.0085)	(0.0670)
Political Terror Scale	0.1171	-0.0320	-0.1248	-0.0356	-0.1697
	(0.2678)	(0.0246)	(0.1547)	(0.0261)	(0.1552)
Counter-Terrorism Aid	-0.0060	0.0021	0.0042	0.0012	0.0005
	(0.0219)	(0.0016)	(0.0118)	(0.0016)	(0.0120)
Terrorism in Neighboring Countries	-0.0010	-0.0003***	-0.0006	-0.0002**	-0.0004
	(0.0008)	(0.0001)	(0.0005)	(0.0001)	(0.0005)
Constant	9.0966**	-2.2173***	-5.7596*	-1.5645**	-3.1288
	(4.1012)	(0.6982)	(3.3188)	(0.7078)	(3.4881)
Country Fixed Effects	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓
Offset	×	✓	✓	✓	✓
Observations	213	272	272	272	272

Notes: Standard errors in parentheses. *p<0.10; **p< 0.05; ***p<0.01. Offset indicates whether the dependent variable was conditioned on the total number of attacks.

Problems of Control and Signaling

Although principal-agent and signaling arguments are made by drone pessimists, the mechanisms associated with them in previous literature are contradictory.[17] Specifically, previous literature has tested two primary mechanisms related to these schools of

[16] *Success* is a binary variable equal to 1 when an attack is defined as successful by the Global Terrorism Database.

[17] Unfortunately, we do not have the necessary data to test the causal mechanisms associated with blowback arguments.

thought: (1) the share of terrorist attacks against government targets, and (2) the share of attacks where a terrorist group claims responsibility.

According to principal-agent arguments, there should be a negative relationship between drones and the share of terrorist attacks against government targets because drones empower lower-level militants that are more willing to target civilians (Abrahms and Potter 2015; Abrahms and Mierau 2017; Rigterink 2021).[18] Some signaling arguments predict the opposite, as terrorist groups arguably have incentives to attack "harder" government targets since they provide a better opportunity to showcase resolve and capability than "softer" targets like civilians.[19]

There are also conflicting arguments when it comes to the share of attacks claimed by terrorist groups. Per principal-agent arguments, drones should be associated with a lower share of attacks claimed by terrorist groups. If drones empower lower-level militants to engage in more indiscriminate violence, then terrorist leaders (who likely still have control over a group's communications) may not want to take credit for these attacks for fear that they will have a negative long-term impact on their group's image and goals. Alternatively, according to the logic of signaling arguments, terrorist groups should be more likely to take credit for attacks in order to ensure the signal is received (Rigterink 2021).

To test these mechanisms, we draw on two additional variables from the Global Terrorism Database. *Government Attacks* is a binary variable equal to 1 when the target type of a terrorist attack is coded as government, military, or police (Abrahms and Potter 2015; Abrahms and Mierau 2017). *Claimed* is a binary variable that equals 1 when a claim of responsibility is made for a terrorist attack (Rigterink 2021).

Beginning with the share of terrorist attacks against government targets, Model 1 in Table 6 does not demonstrate statistically significant support for either perspective. This null result also holds for the *UAV Strike* variable and if only attacks targeting

[18] Terrorist groups may also be incentivized to avoid government targets in order to protect their personnel from drone strikes and other counter-terrorism operations (Gartzke and Walsh 2022).

[19] Note that even if armed UAV programs are associated with fewer *total* attacks, the *share* of attacks targeting different entities could still go up or down.

the military and police are included in the dependent variable measure. In Models 2 and 3, we look at the total (rather than share) of attacks aimed at government or non-government targets. Consistent with the capacity arguments of drone optimists, *Armed UAV Possession* is associated with fewer of *both* types of attacks. Finally, in Model 4 we examine whether armed UAV programs impact the share of attacks claimed by terrorist groups. No statistically significant evidence is found for either perspective, and this null result holds for the *UAV Strike* variable as well. Overall, then, we find little evidence for the mechanisms posited by drone pessimists.

Table 6: Causal Mechanisms: Problems of Control and Signaling

	(1) Government Target Share	(2) Government Attacks	(3) Non-Government Attacks	(4) Claimed Rate
Armed UAV Possession	-0.0253	-0.3160*	-0.5168***	0.1136
	(0.0887)	(0.1893)	(0.1847)	(0.1461)
GDP per Capita	0.9910***	0.7620*	-0.2455	0.1348
	(0.2784)	(0.4205)	(0.3625)	(0.3405)
Level of Democracy	-0.0035	0.0725***	0.0542***	0.0527***
	(0.0069)	(0.0184)	(0.0203)	(0.0123)
Civil War	0.2009*	0.0038	0.0039	-0.2795
	(0.1187)	(0.2820)	(0.3072)	(0.1937)
Failed State	-0.0876**	0.4603***	0.5400***	-0.0354
	(0.0342)	(0.0941)	(0.0872)	(0.0633)
Political Terror Scale	-0.1261**	0.0871	0.1748	0.1392
	(0.0632)	(0.1479)	(0.1334)	(0.1050)
Counter-Terrorism Aid	-0.0037	-0.0067	0.0059	0.0237**
	(0.0065)	(0.0134)	(0.0129)	(0.0119)
Terrorism in Neighboring Countries	0.0014***	0.0005	-0.0010	0.0010**
	(0.0003)	(0.0006)	(0.0006)	(0.0005)
Constant	-11.4737***	-6.3814	5.1706	-3.1900
	(2.9969)	(4.4471)	(3.7833)	(3.6280)
Country Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
Offset	✓	×	×	✓
Observations	272	335	335	272

Notes: Standard errors in parentheses. *p<0.10; **p< 0.05; ***p<0.01. Offset indicates whether the dependent variable was conditioned on the total number of attacks.

Conclusion

To date, existing research on how drones influence terrorism has mostly focused on the short-term effect of the U.S. drone program in Pakistan. This paper provides two central contributions relative to these previous studies. First, we leverage a rapid increase in armed UAV proliferation in recent years and a new time-series cross-sectional dataset that captures this development to move beyond the American context and analyze a broader universe of cases. Second, our design allows us to comment on the longer-term strategic effects of armed UAV programs, which is contested. While previous research examines how drones impact monthly, weekly, or even daily levels of terrorism, our research design focuses on yearly levels of terrorism.

We find consistent evidence that armed drone programs are associated with a decrease in terrorism. Our analysis shows that obtaining armed UAVs is associated with 5.5 fewer terrorist attacks per year, a 35% decrease. The benefit is even greater for states that have conducted at least one drone strike, as they face 7.25 fewer attacks per year. This supports the view that drones can be effective counter-terrorism tools and contradicts arguments that drones are, on balance, counter-productive. More generally, this adds to growing evidence that military technologies—ranging from satellites to nuclear weapons—can reduce a country's vulnerability to politically-motivated violence (Early and Gartzke 2021; Lee et al. forthcoming).

These results also have important policy implications. Our findings imply that the strongest argument against drones—that they fail to accomplish their primary objective of reducing terrorism—is not accurate. This conclusion is also supported by many previous micro-level studies on the impact of the U.S. drone program in Pakistan (Johnston and Sarbahi 2016; Mir 2018; Mir and Moore 2019; Loidolt 2022). Therefore, countries that value countering terrorism above all other objectives may find acquiring armed drones attractive. On the other hand, our results by no means suggest that drones are a panacea or a net positive for the world. Acquiring and using armed drones can also have significant detrimental effects. Most notably, of course, are the civilian casualties and psychological stress caused by UAVs. Moreover, like any other weapon, drones can be used for more or less ethical purposes.

This paper also suggests a number of promising avenues for future research. First, what characteristics of armed UAV programs and terrorist groups impact whether drones are more or less effective? For example, do they become more effective over time as states become more capable drone operators (Gilli and Gilli 2016) and acquire more sophisticated platforms, or less effective as terrorist groups learn to adapt (Jordan 2014)?[20] Second, what impact do armed drones have on specific terrorist groups (Fortna, Lotito, and Rubin 2022)? Third, would evidence of drones' counter-terrorism effectiveness outside of the U.S. context impact international support for UAVs and their perceived morality (Kreps and Wallace 2016; Fisk, Merolla, and Ramos 2019)? Fourth, how does the acquisition of armed UAVs by *terrorist* groups impact their ability to carry out attacks (Chávez and Swed 2021)? Fifth, while armed UAVs may provide counter-terrorism benefits, are they a stabilizing or destabilizing force in the realm of interstate conflict (Horowitz, Kreps, and Fuhrmann 2016; Lyall 2020; Zegart 2020; Lin-Greenberg 2021)? Finally, how do drones fit into states' grand strategies more broadly (Hazelton 2017)? Do they enable more activist foreign policies or facilitate restraint?

[20] Initial results presented in the appendix suggest armed drones may become more effective over time.

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