

Supplementary Materials

**Do Armed Drones Counter Terrorism,
Or Are They Counter-Productive?
Evidence from 18 Countries***

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*This is one of several joint articles by the authors; the ordering of names reflects a principle of rotation with equal authorship implied.

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Robustness Tests

Iteratively Dropping Countries

In Table S.1 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.¹

Table S.1a: Iteratively Dropping Countries

	(1)	(2)	(3)	(4)	(5)	(6)
	Attacks	Attacks	Attacks	Attacks	Attacks	Attacks
Armed UAV Possession	-0.7249*** (0.1851)	-0.4536** (0.1906)	-0.7751*** (0.2013)	-0.3659* (0.2025)	-0.3327* (0.1766)	-0.4416** (0.1750)
GDP per Capita	-0.5713 (0.3579)	-0.2329 (0.3445)	-0.7615** (0.3877)	-0.2398 (0.3574)	-0.2835 (0.3327)	-0.2746 (0.3653)
Level of Democracy	0.0687*** (0.0180)	0.0613*** (0.0198)	0.0681*** (0.0177)	0.0596*** (0.0201)	0.0843*** (0.0182)	0.0638*** (0.0198)
Civil War	-0.1543 (0.2564)	-0.0423 (0.3489)	-0.1203 (0.2979)	0.0162 (0.2896)	0.0563 (0.2791)	-0.0614 (0.2776)
Failed State	0.5045*** (0.0866)	0.5411*** (0.0958)	0.4662*** (0.0932)	0.5511*** (0.0882)	0.5974*** (0.0878)	0.5489*** (0.0892)
Political Terror Scale	0.3536** (0.1534)	0.1522 (0.1456)	0.3590** (0.1644)	0.0602 (0.1486)	0.1236 (0.1297)	0.1559 (0.1404)
Counter-Terrorism Aid	-0.0076 (0.0124)	-0.0016 (0.0129)	-0.0129 (0.0132)	-0.0005 (0.0124)	0.0086 (0.0119)	-0.0011 (0.0123)
Terrorism in Neighboring Countries	-0.0012** (0.0006)	-0.0004 (0.0006)	-0.0014** (0.0006)	-0.0007 (0.0006)	-0.0004 (0.0006)	-0.0004 (0.0006)
Constant	6.8409* (3.6273)	5.2911 (3.6043)	8.6024** (3.9243)	5.5801 (3.7581)	5.7945* (3.4692)	5.8267 (3.7948)
Model	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial
Country Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Lagged DV	✓	✓	✓	✓	✓	✓
Country Dropped	USA	Israel	USA & Israel	UK	Iran	UAE
Observations	316	316	297	316	316	316

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

¹Our results for *UAV Strike* are also robust to dropping both the United States and Israel.

Table S.1b: Iteratively Dropping Countries, continued

	(7)	(8)	(9)	(10)	(11)	(12)
	Attacks	Attacks	Attacks	Attacks	Attacks	Attacks
Armed UAV Possession	-0.3907** (0.1849)	-0.4397*** (0.1672)	-0.4465*** (0.1684)	-0.5091*** (0.1631)	-0.4502** (0.1785)	-0.3929** (0.1689)
GDP per Capita	0.4756 (0.3835)	-0.2393 (0.3238)	0.0149 (0.3288)	0.1244 (0.3265)	-0.0458 (0.3608)	-0.0096 (0.3420)
Level of Democracy	0.0513** (0.0214)	0.0678*** (0.0195)	0.0596*** (0.0194)	0.0621*** (0.0194)	0.0452* (0.0272)	0.0532** (0.0216)
Civil War	0.0370 (0.3005)	0.1247 (0.2720)	-0.0781 (0.2841)	-0.0685 (0.2628)	0.0871 (0.2592)	-0.3738 (0.3523)
Failed State	0.5523*** (0.0938)	0.4890*** (0.0922)	0.5586*** (0.0897)	0.6041*** (0.0898)	0.6312*** (0.1126)	0.5263*** (0.0947)
Political Terror Scale	0.1160 (0.1367)	0.1377 (0.1385)	0.1024 (0.1325)	0.1031 (0.1307)	0.1904 (0.1432)	0.1742 (0.1323)
Counter-Terrorism Aid	0.0023 (0.0122)	-0.0008 (0.0135)	0.0011 (0.0122)	-0.0013 (0.0115)	0.0067 (0.0132)	0.0007 (0.0125)
Terrorism in Neighboring Countries	-0.0004 (0.0005)	0.0001 (0.0006)	-0.0000 (0.0005)	-0.0008 (0.0005)	-0.0003 (0.0005)	-0.0004 (0.0006)
Constant	-2.0971 (3.9543)	5.4766 (3.3726)	2.9655 (3.4267)	1.7963 (3.4160)	3.5602 (3.7483)	3.0883 (3.5550)
Model	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial
Country Fixed Effects	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Lagged DV	✓	✓	✓	✓	✓	✓
Country Dropped	China	Nigeria	South Africa	Saudi Arabia	Turkey	Iraq
Observations	316	316	316	316	316	323

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

Table S.1c: Iteratively Dropping Countries, continued

	(13)	(14)	(15)	(16)	(17)	(18)	(19)
	Attacks	Attacks	Attacks	Attacks	Attacks	Attacks	Attacks
Armed UAV Possession	-0.3618** (0.1685)	-0.4294** (0.1722)	-0.4325** (0.1744)	-0.4517*** (0.1747)	-0.4355** (0.1709)	-0.4695*** (0.1774)	-0.4404** (0.1781)
GDP per Capita	-0.0043 (0.3240)	0.0047 (0.3385)	-0.2768 (0.3526)	-0.1069 (0.3586)	-0.1363 (0.3381)	-0.1105 (0.3440)	-0.6332 (0.3861)
Level of Democracy	0.0622*** (0.0189)	0.0581*** (0.0200)	0.0784*** (0.0245)	0.0614*** (0.0198)	0.0612*** (0.0198)	0.0650*** (0.0199)	0.0195 (0.0283)
Civil War	0.1080 (0.2614)	-0.0116 (0.2848)	-0.1187 (0.4529)	-0.0852 (0.2747)	-0.0195 (0.2855)	-0.0131 (0.2816)	-0.0064 (0.3039)
Failed State	0.4720*** (0.0888)	0.5245*** (0.0896)	0.5432*** (0.1176)	0.5328*** (0.0920)	0.5452*** (0.0896)	0.5519*** (0.0889)	0.6301*** (0.0986)
Political Terror Scale	0.1727 (0.1267)	0.1496 (0.1337)	0.1386 (0.1404)	0.2278 (0.1389)	0.1541 (0.1337)	0.1472 (0.1349)	0.0713 (0.1453)
Counter-Terrorism Aid	-0.0061 (0.0120)	0.0046 (0.0123)	-0.0012 (0.0136)	0.0028 (0.0132)	0.0015 (0.0121)	-0.0013 (0.0121)	-0.0018 (0.0127)
Terrorism in Neighboring Countries	0.0001 (0.0005)	-0.0003 (0.0005)	0.0002 (0.0006)	-0.0005 (0.0008)	-0.0004 (0.0005)	-0.0006 (0.0006)	-0.0002 (0.0005)
Constant	2.9087 (3.3843)	2.9470 (3.5340)	5.6797 (3.6100)	3.9352 (3.7537)	4.3795 (3.5306)	4.0689 (3.5923)	10.2934** (4.1881)
Model	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial
Country Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Lagged DV	✓	✓	✓	✓	✓	✓	✓
Country Dropped	Egypt	Uzbekistan	Pakistan	Jordan	Turkmenistan	Kazakhstan	Myanmar
Observations	316	316	316	316	316	316	316

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

Increasing the Comparability of the Pre/Post-Acquisition Periods

In Table S.2 we utilize an additional strategy to increase the comparability of the pre- and post-acquisition periods. Specifically, we limit the analysis to the 3, 2, or 1 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 since fewer factors are likely changing between the treatment and control groups. Lee et al. (forthcoming) adopt a similar strategy 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).

Table S.2: Narrowing the Time Frame Under Study

	(1) Attacks (3 Years Pre/Post)	(2) Attacks (2 Years Pre/Post)	(3) Attacks (1 Year Pre/Post)
Armed UAV Possession	-0.4624** (0.2178)	-0.4369** (0.2211)	-0.4504** (0.2171)
GDP per Capita	1.2577 (1.3330)	2.8869 (1.8663)	1.3131 (1.7780)
Level of Democracy	0.0494 (0.0328)	0.0504 (0.0352)	0.0928*** (0.0332)
Civil War	0.6581** (0.2896)	0.3995 (0.2683)	0.0012 (0.2630)
Failed State	-0.1579 (0.1352)	-0.1520 (0.1505)	-0.2705*** (0.0904)
Political Terror Scale	0.5786*** (0.2062)	0.7863*** (0.2362)	1.2649*** (0.2684)
Counter-Terrorism Aid	-0.0007 (0.0165)	0.0037 (0.0155)	0.0066 (0.0169)
Terrorism in Neighboring Countries	0.0002 (0.0009)	0.0008 (0.0012)	0.0031* (0.0017)
Constant	-9.8273 (14.1415)	-27.9341 (19.9047)	-12.0698 (19.1869)
Model	Negative Binomial	Negative Binomial	Negative Binomial
Country Fixed Effects	✓	✓	✓
Year Fixed Effects	✓	✓	✓
Lagged DV	✓	✓	✓
Observations	123	88	53

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

Additional/Alternative Control and Dependent Variables

Table S.3 shows our results are robust to adding additional control variables, operationalizing our control variables differently, and using an alternative dependent variable.

Model 1 adds two additional control variables to our main specification. First, we include a variable developed by Hendrix and Young (2014) that measures a state’s bureaucratic and administrative capacity, which could affect both a state’s ability to acquire armed UAVs and terrorist groups’ chances of successfully carrying out attacks. We construct this variable using factor analysis on two variables collected from the International Country Risk Guide: (a) bureaucratic quality and (b) law and order.² Second, we measure a country’s military spending as a percentage of GDP using data from SIPRI (2020). We control for this factor because if countries are pursuing other counter-terrorism strategies in tandem with armed UAVs, then their share of military spending may also increase. Note that we do not include these variables in our main models due to missing data.

In Model 2 we show our results are robust to the use of a different measure of democracy: V-Dem (Coppedge et al. 2019). Model 3 shows our findings also hold when we include an interaction term between a binary non-democracy variable constructed from Polity and a time dummy for whether the year is before 2011. We test the robustness of our results to the inclusion of this interaction term because Horowitz, Schwartz, and Fuhrmann (2022) found that the supply shock of China entering the armed drone export market in 2011 significantly changed the relationship between regime type and armed UAV proliferation.

Models 4 and 5 demonstrate our results are robust to two alternative measures of counter-terrorism aid: (a) funds from the State Department’s Nonproliferation, Anti-Terrorism, Demining, and Other Related Programs (NADR) designated for counter-terrorism,³ and (b) a measure that includes all “security” aid listed in the U.S. Greenbook.

In Model 6 we use an alternative spatial lag variable: the number of terrorist attacks

²A country scores high in bureaucratic quality if they have regular and meritocratic recruitment and advancement processes; insulation from political pressure; and the ability to provide services during government changes. The law and order variable measures the strength and impartiality of the legal system and popular observance of the law.

³Bapat (2011) and Boutton (2019) use total NADR aid in their studies of terrorism.

in neighboring countries separated by a land border rather than attacks in countries separated by a land *or* sea border.

Lastly, Model 7 shows that our results are robust to the use of an alternative dependent variable—*Suicide Attacks*—from the Database on 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).⁴

Table S.3: Additional/Alternative Control and Dependent Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Terror Attacks	Terror Attacks	Terror Attacks	Terror Attacks	Terror Attacks	Terror Attacks	Suicide Attacks
Armed UAV Possession	-0.3777** (0.1769)	-0.4130** (0.1700)	-0.5057*** (0.1638)	-0.4570*** (0.1678)	-0.4570*** (0.1707)	-0.4276** (0.1671)	-1.5302*** (0.4159)
GDP per Capita	-0.1436 (0.4122)	-0.0570 (0.3368)	0.0096 (0.3682)	-0.1361 (0.3359)	-0.1017 (0.3387)	-0.1519 (0.3340)	1.2062 (0.8298)
Level of Democracy	0.0015 (0.0308)			0.0550*** (0.0207)	0.0589*** (0.0200)	0.0616*** (0.0196)	0.0500 (0.0648)
Civil War	0.2262 (0.3145)	0.1062 (0.2679)	0.1003 (0.2874)	0.0042 (0.2749)	-0.0139 (0.2814)	-0.0467 (0.2858)	-0.3759 (0.5985)
Failed State	0.6313*** (0.1034)	0.5692*** (0.0893)	0.5209*** (0.0897)	0.4908*** (0.1008)	0.5364*** (0.0907)	0.5477*** (0.0900)	0.7619*** (0.1964)
Political Terror Scale	0.0932 (0.1440)	0.1495 (0.1294)	0.0393 (0.1367)	0.1558 (0.1328)	0.1564 (0.1337)	0.1493 (0.1333)	0.3221 (0.3305)
Counter-Terrorism Aid	0.0027 (0.0131)	0.0030 (0.0119)	0.0069 (0.0118)			-0.0011 (0.0122)	0.0386 (0.0270)
Terrorism in Neighboring Countries	-0.0001 (0.0005)	-0.0003 (0.0005)	-0.0010* (0.0005)	-0.0004 (0.0005)	-0.0003 (0.0005)		-0.0019 (0.0013)
State Capacity	0.9066 (0.6074)						
Mil Spending / GDP	0.1201 (0.0889)						
V-Dem		2.5438*** (0.6374)					
Non-Democracy (After China Shock)			-0.2078 (0.1854)				
Period 1 (2001-2010)			-1.2469*** (0.4267)				
Non-Democracy X Period 1			-0.8081*** (0.2596)				
NADR Aid				0.0200 (0.0138)			
All Security Aid					0.0184 (0.0181)		
Terrorism in Neighboring Countries (Land)						0.0000 (0.0005)	
Constant	3.4161 (4.7695)	1.9935 (3.5314)	5.1007 (4.0557)	4.4874 (3.5194)	4.0845 (3.5343)	4.5488 (3.4799)	-14.4057 (8.9108)
Model	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial	Negative Binomial
Country Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Lagged DV	✓	✓	✓	✓	✓	✓	✓
Observations	277	342	342	335	335	335	335

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

⁴We only include confirmed suicide attacks in our analysis.

Alternative Modeling Choices

In Table S.4 we show our results are also robust to different modeling choices. Given the challenges associated with interpreting two-way fixed effect models (Imai and Kim 2020; Kropko and Kubinec 2020), in Model 1 we include only country fixed effects.⁵ Model 2 removes the lagged dependent variable, Model 3 uses a Poisson model rather than a negative binomial model, and Model 4 begins the analysis in 1998 instead of 2001.

Table S.4: Alternative Modeling Choices

	(1)	(2)	(3)	(4)
	Attacks	Attacks	Attacks	Attacks
	(2001-2019)	(2001-2019)	(2001-2019)	(1998-2019)
Armed UAV Possession	-0.5606*** (0.1574)	-0.4418*** (0.1709)	-0.4653** (0.2047)	-0.4429*** (0.1710)
GDP per Capita	1.7689 (1.1595)	-0.1147 (0.3294)	1.6378** (0.7160)	-0.1280 (0.3349)
Level of Democracy	0.0474 (0.0309)	0.0604*** (0.0185)	0.0490** (0.0192)	0.0621*** (0.0197)
Civil War	0.6178** (0.2640)	-0.0605 (0.2602)	0.4369*** (0.1603)	-0.0359 (0.2800)
Failed State	0.2598** (0.1091)	0.5380*** (0.0852)	0.3408*** (0.0692)	0.5477*** (0.0892)
Political Terror Scale	-0.2589* (0.1443)	0.1514 (0.1311)	0.0950 (0.2037)	0.1551 (0.1336)
Counter-Terrorism Aid	-0.0084 (0.0095)	0.0004 (0.0120)	-0.0135 (0.0148)	0.0005 (0.0121)
Terrorism in Neighboring Countries	0.0014** (0.0005)	-0.0004 (0.0005)	-0.0003 (0.0005)	-0.0004 (0.0005)
Constant	-27.0095 (31.3322)	4.1616 (3.4522)	-14.8372** (7.4802)	4.2826 (3.4964)
Model	Negative Binomial	Negative Binomial	Poisson	Negative Binomial
Country Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	×	✓	✓	✓
Lagged DV	✓	×	✓	✓
Observations	335	335	335	335

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

⁵We also include country-specific time trends, but remove year fixed effects.

Modeling Armed Drone Sophistication

Given the relatively small number of observations available for our analysis, in the main text we treat all drones as equivalent in order to maximize statistical power. Of course, we recognize that some drones are more sophisticated than others and model this fact in [Table S.5](#). To do so, we first code an additional binary variable: *Sophisticated Armed UAV Possession*. This variable takes the value of 1 if a state is in possession of a “sophisticated” armed UAV and 0 otherwise. We code drones as sophisticated if they meet the criteria outlined by Fuhrmann and Horowitz (2017) to be considered an “advanced” UAV.⁶ Coding-wise, this yields the same result as using Gettinger’s (2019) distinction between Class II and Class III UAVs to categorize UAVs as advanced or not.

Model 1 in [Table S.5](#) demonstrates that our core result is robust to the use of this alternative explanatory variable. Interestingly, Model 2 shows that there is not a significant interaction between our strike variable and our sophistication variable. In other words, we do not find significant evidence that drone strikes reduce terrorism to a greater extent when states have advanced drones. As more data becomes available, a promising avenue for future research would be to more thoroughly study how drone sophistication impacts effectiveness.

⁶Specifically, to qualify as advanced a drone must be able to remain in the air for at least twenty hours, operate at an altitude of at least 16,000 feet, and have a maximum takeoff weight of at least 1,320 pounds.

Table S.5: Modeling Armed Drone Sophistication

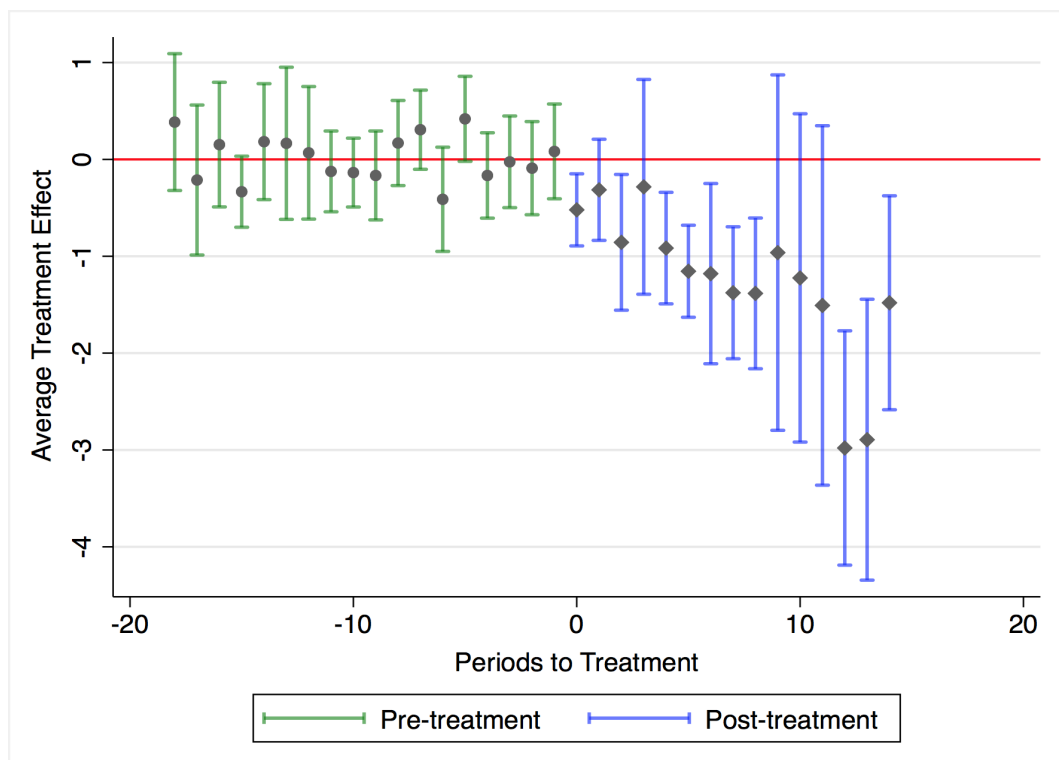
	(1)	(2)
	Attacks	Attacks
Sophisticated Armed UAV Possession	-0.7996***	-0.7107***
	(0.1668)	(0.2267)
UAV Strike		-0.2914
		(0.2438)
Sophisticated Armed UAV Possession x UAV Strike		0.0664
		(0.302)
GDP per Capita	-0.2586	-0.3494
	(0.3199)	(0.3342)
Level of Democracy	0.0401**	0.0402**
	(0.0187)	(0.0182)
Civil War	-0.0219	-0.0613
	(0.2515)	(0.2529)
Failed State	0.5322***	0.5456***
	(0.0888)	(0.0908)
Political Terror Scale	0.1092	0.1022
	(0.1304)	(0.1318)
Counter-Terrorism Aid	-0.0014	-0.0025
	(0.0120)	(0.0120)
Terrorism in Neighboring Countries	-0.0000	-0.0001
	(0.0005)	(0.0005)
Constant	6.2370*	7.2945**
	(3.3512)	(3.5292)
Observations	335	335

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

Modeling Heterogeneous Treatment Effects

Figure S.1 illustrates how the impact of armed UAVs on terrorism changes over time using the Callaway and Sant’Anna (2021) estimator from Model 6 in the main text. There are three principal takeaways from this plot. First, there is no significant evidence of pre-treatment trends, providing evidence for the parallel trends assumption. Second, as the negative post-treatment estimates illustrate (most of which are individually significant), armed drones are clearly associated with less terrorism on average. Third, if anything, the negative relationship between armed UAVs and terrorism appears to be somewhat increasing over time, meaning that the simple two-way fixed effects models utilized in the main text are likely a conservative estimate of the impact of armed UAVs on terrorism.

Figure S.1: Impact of Armed Drones Over Time

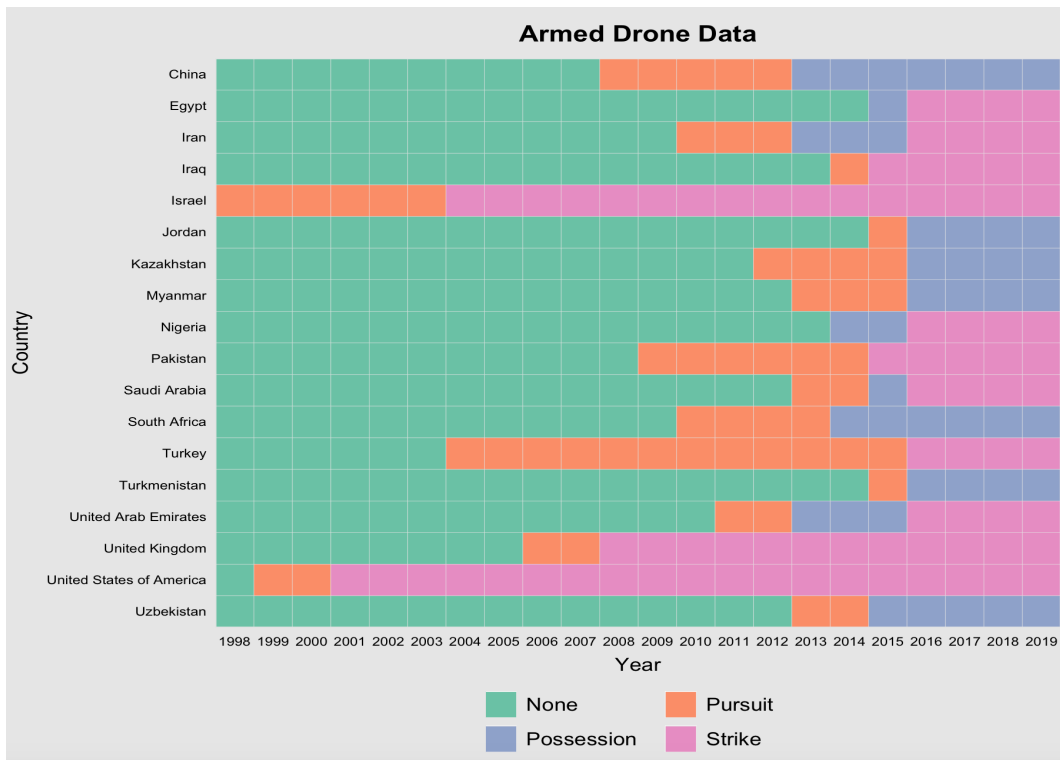


Armed Drone Data Sources

We construct three primary dichotomous variables: *Armed UAV Possession* (does a state have armed drones?), *UAV Strike* (has a state fired munitions from drones?), and *Armed UAV Pursuit* (has a state pursued armed drones?). We categorize countries as having acquired armed UAVs if they either: (1) developed a functional armed UAV indigenously or (2) imported an armed UAV from a foreign producer.⁷ *UAV Strike* is a variable that measures whether countries have actually fired munitions from drones. Following Fuhrmann and Horowitz (2017) and Horowitz, Schwartz, and Fuhrmann (2022), we classify states as having pursued armed UAVs if at least one of the three following conditions is met: (1) an entity within a country is currently developing or has committed to develop an armed UAV or an armed UAV demonstrator; (2) the government of a country has stated its intent to acquire armed UAVs in an official policy document or speech; or (3) the government of a country has attempted to purchase an armed UAV. The values of our three primary variables over time and by country are plotted in [Figure S.2](#).

⁷Unrecoverable drones, also known as suicide or kamikaze drones, are not coded as armed UAVs. They are one-way systems arguably more akin to cruise missiles than aircraft. Moreover, they can be produced relatively easily by, for example, adding a grenade to commercial drones available on Amazon, as groups like the Islamic State have done.

Figure S.2



China

- Jane’s Defence Weekly: Ted Parsons, “China Targets Unmanned Combat Platform Development,” July 21, 2008.
- New York Times
- Stockholm International Peace Research Institute

Egypt

- Anadolu Agency
- Drone Wars UK
- Foreign Policy
- Popular Mechanics
- Stockholm International Peace Research Institute
- The Diplomat

Iran

- [Bard Drone Center](#)
- [BBC](#)
- [Jane's Defence Weekly: "Iran Shows Off Latest UAVs,"](#) October 2, 2013.
- [Jane's Defence Weekly: Jeremy Binnie, "Analysis: Syrian Rebel Video Corroborates Iranian UAV Strike Claims,"](#) February 12, 2016.
- [UPI](#)

Iraq

- [Drone Wars UK](#)
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