Who's Prone to Drone?

A Global Time-Series Analysis of Armed Uninhabited Aerial Vehicle Proliferation

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Abstract

What determines whether countries pursue and obtain armed drones? Using an original time-series dataset, we conduct the first comprehensive analysis of armed drone proliferation from 1994-2019. We theorize and find evidence that security threats—like terrorism—are not the only factors driving proliferation. Regime type also has a significant effect, but it varies over time. From 1994-2010 regime type had no significant effect. However, non-democracies became significantly more likely to pursue and obtain armed drones from 2011-2019 due to China's entrance into the drone export market, which asymmetrically eased supply-side constraints for non-democracies. We also find that status-seeking states are more likely to pursue armed drones. Our results contribute to the broader academic literature on proliferation by demonstrating how supply shocks can lead to changes in proliferation trends over time and lending further credence to the importance of prestige in international politics.

Debates about the key technologies for militaries around the world over the next generation almost always include uninhabited aerial vehicles (UAVs), more popularly known as "drones." And for good reason. The spread of drones—and especially armed drones—has significant consequences for international politics. Armed drones can serve as tools of counterinsurgency and counterterrorism, as Turkish drone strikes against the Kurds and the U.S. drone campaign in Afghanistan and Pakistan illustrate (Johnston and Sarbahi, 2016; Mir and Moore, 2019). The proliferation of armed drones also has important implications for interstate coercion and escalation dynamics (Lin-Greenberg, 2019; Zegart, 2020). For example, in an effort to deter future Iranian attacks, the U.S. assassinated general Qasem Soleimani, head of the Islamic Revolutionary Guards Corps (IRGC) Quds Force, utilizing an armed drone. Houthi rebels also used armed drones to attack Saudi oil-processing facilities in September 2019, possibly with assistance from Iran. Given the increasing relevance of armed drones to international politics, we conduct what is, to our knowledge, the first systematic analysis of armed aerial drone proliferation using new time-series cross-national data on 168 countries from 1994 to 2019.

While a growing number of books and articles examine the causes of drone proliferation, until very recently, there were too few states with armed drones to make rigorous quantitative analysis feasible (Kreps, 2016; Fuhrmann and Horowitz, 2017; Walsh and Schulzke, 2018; Horowitz 2020). Twenty-two countries now possess armed drones and more than twenty others are pursuing this capability. Armed drones are spreading at a rapid clip: just eight states had armed drones at the end of 2014, meaning that adoption has almost tripled in less than five years.

The literature on nuclear proliferation distinguishes between demand and supply-side factors as proliferation predictors (e.g., Sagan, 2011; Fuhrmann 2012; Gartzke, Kaplow, and Mehta, 2014). Demand-side factors are those that affect whether states have the desire to pursue

and acquire a particular military technology, while supply-side factors are those that affect whether they actually have the capability to do so. Using this framework, we advance two principal hypotheses about the spread of armed drones from 1994 to 2019. First, we theorize that a supply shock in 2011 changed the relationship between regime type and armed drone proliferation. Specifically, China emerged as a viable supplier of armed UAVs in 2011, which we argue asymmetrically eased supply-side constraints for non-democracies, making them more likely to acquire than democracies.

Previous research shows that countries are more likely to trade arms with each other if they have similar regime types (Akerman and Seim, 2014; Thurner et al., 2019). For example, non-democracies may prefer to purchase weapons from non-democratic exporters because they are less likely to make arms sales conditional on the weapons being used in accordance with international law and human rights principles (e.g., Blanton, 2005; Li and Matthews, 2017). We would thus expect, *a priori*, non-democracies to be more likely to acquire armed drones from China, and democracies to be more likely to obtain armed drones from major democratic suppliers; namely, the United States. However, while China was willing and able to sell armed drones to non-democracies, even those that violate human rights, the United States was constrained by its membership in the Missile Technology Control Regime (MTCR), which restricts exports of Category I systems that travel more than 300 kilometers and have a payload greater than 500 kilograms, a threshold that all US armed drones exceed (Nacouzi et al., 2018). This, we expect, gave non-democracies a supply-side advantage.

In accordance with this hypothesis, we find that non-democracies were significantly more likely than democracies to acquire armed drones after China entered the export market. Indeed, we uncover a striking pattern: nineteen countries have fielded armed drones since 2010, and only four

of them were democratic in the first year of possession. To test our theory that a Chinese supply shock is driving this result, we also show that non-democracies were more likely to import armed UAVs from China specifically. Additionally, we find that a similar dynamic does *not* hold for the proliferation of military drones in general, illustrating that the causes of armed and unarmed drone proliferation can differ under certain circumstances and so studying them separately is beneficial. Given the potential for armed drones in particular to be used in lethal operations abroad or domestically (Horowitz, Kreps, and Fuhrmann, 2016), it makes sense that democracies would be more hesitant to sell armed drones compared to unarmed drones (Kaag and Kreps, 2014: chapter 5).

We also theorize about how prestige and status-seeking influence armed drone proliferation. Previous research recognizes that military technologies may confer status on countries that possess them (O'Neill, 2006; Gilady, 2018; Musgrave and Nexon, 2018). Evidence of this, however, is mostly limited to case studies (e.g., Farrell, 2005) and indirect quantitative measures (e.g., Suchman and Eyre, 1996; Jo and Gartzke, 2007). Building on this work, we argue that demand for armed drones should be greater among countries seeking status.

Using multiple metrics of status-seeking (Early 2014; Renshon 2016), we show that status-seeking countries are more likely than their non status-seeking counterparts to pursue armed drones. By comparison, Fuhrmann and Horowitz (2017) only find that status-seeking countries are more likely to pursue and acquire "basic" UAV systems, *not* armed systems.

Overall, this paper makes several contributions. Our theory and findings regarding regime type show that supply and demand shocks can lead to changes in proliferation trends over time, a possibility that most research on the spread of military technologies ignores (Sagan, 2011: 237-240). Moreover, although most proliferation studies conceive of regime type as solely affecting

demand for a particular military technology (Singh and Way, 2004; Jo and Gartzke, 2007; Caverley, 2009; Sechser and Saunders, 2010; Fuhrmann and Horowitz 2017), we show that it can also interact with supply-side factors in important ways.

Additionally, our findings with respect to status lend additional credence to previous studies that find non-material considerations—such as prestige—can influence the pursuit of military technologies. The low cost of drones relative to other military technologies makes them particularly attractive for states seeking to enhance their status internationally. However, if armed drones become ubiquitous in world politics, they may lose their prestige value over time.

Finally, our new dataset tracking the pursuit and acquisition of armed drones from 1994 to 2019 advances previous empirical work by Fuhrmann and Horowitz (2017). Most importantly, our dataset goes through 2019 and measures whether countries have actually *acquired* armed drones, whereas Fuhrmann and Horowitz (2017) only measure states' drone capabilities up to 2014 and whether states *pursued* armed (and unarmed) drones. This is significant because a majority of states that have acquired armed drones have done so after 2014 and armed drone acquisition has a greater impact on international politics than pursuit. Moreover, the analysis in this paper is based on time-series data, whereas Fuhrmann and Horowitz's (2017) data is cross-sectional, identifying capabilities at a single point in time: December 31, 2014. As described above, the ability to study variation over time is critical to our theory and results regarding regime type and allows us to uncover patterns that non-time-series data would miss.

This paper proceeds in four main parts. First, we develop a theory of the spread of armed drones, building on the existing literature by focusing on regime type and status in more detail. Second, we introduce our new dataset and research design. Third, we present the findings of

several hazard models designed to test our hypotheses. The fourth section concludes by highlighting the contributions of this study and suggesting directions for future research.

The Effect of Regime Type: Two Distinct Periods

Regime type is a distinguishing characteristic of states that plays a critical role in many prominent "second image" theories like the democratic peace theory. Theoretically, regime type also represents one key factor that may affect a state's demand for a particular military technology and/or ability to build or buy the technology. On the demand side, since democracies and non-democracies tend to differ in terms of their values, institutional constraints, and expected security challenges, their incentives to pursue and acquire military technologies may also differ. On the supply side, regime type can affect who countries are willing to import arms from and who countries are willing to export arms to.

Previous research, however, finds only mixed support for the relationship between regime type and the development of military capabilities (Singh and Way, 2004; Jo and Gartzke, 2007; Caverley, 2009; Sechser and Saunders, 2010; Way and Weeks, 2014). One reason for these mixed findings, especially in the nuclear proliferation literature, might be that these studies tend to "oversimplify" the role that regime type plays (Sagan, 2011: 237).[1] For example, in studying nuclear proliferation, Sagan argues that the nuclear Nonproliferation Treaty (NPT) represented a shock in time that changed the relationship between regime type and nuclear proliferation, evidenced by the fact that no democracies have cheated on their NPT commitments, while non-democracies have a spottier track record (Sagan, 2011: 237-240).

[1] A notable exception is Way and Weeks (2014), who find that regime type has a significant effect on nuclear proliferation by disaggregating non-democracies into personalist and non-personalist dictatorships.

Political scientists have used economic and political shocks to explain, among other things, interstate rivalry (Goertz and Diehl, 1995); intrastate violence (Nielsen et al., 2011); coups (Kim, 2014); democratization (Gunitsky, 2014); and alliance politics (Berkemeier and Fuhrmann, 2018). However, as noted by Sagan (2011), they have not been sufficiently utilized to explain nuclear proliferation, or, indeed, weapons proliferation in general. Following his suggestion, we incorporate shocks into the canonical supply and demand framework in order to better explain changes in proliferation over time and uncover the (sometimes hidden) role of regime type. According to basic economic theory, a positive supply and/or demand shock leads to an increase in the quantity of a good. Similarly, we theorize that a significant supply shock in 2011 led to the development of two distinct periods of drone proliferation: 1994 to 2010 and 2011 to 2019. From 1994 to 2010, democracies and non-democracies had countervailing reasons to demand armed drones (Fuhrmann and Horowitz 2017) and both faced significant supply-side constraints. Consequently, we expect regime type to have no significant effect during the first period of proliferation. In 2011, the entrance of China into the armed drone export market constituted a significant supply shock that asymmetrically eased supply-side constraints for non-democracies. Thus, from 2011 to 2019 we expect non-democracies to be more likely to pursue and acquire armed drones than democracies.

Period I: 1994 – 2010

During the first period of armed drone proliferation, both democracies and non-democracies had unique, countervailing reasons to demand armed drones (Fuhrmann and Horowitz, 2017). Since democratic leaders tend to value human life and fear the electoral consequences of having their own soldiers killed more than non-democratic leaders, armed drones may have been especially

attractive to democracies because they allow countries to avoid putting their pilots at risk. Attempts by democratic leaders to shield the public from the consequences of war fits Caverley's (2009) argument that democracies prefer capital-intensive militaries rather than labor-intensive ones. Democracies may also demand armed drones because they tend to care more about minimizing non-combatant casualties than non-democracies. Given their ability to loiter over a target for significantly longer than their inhabited equivalents, and the low-yield warheads placed on current armed UAVs, armed drone operators can wait for the ideal moment to strike in order to minimize civilian casualties (Byman, 2013). Due to these factors, some democratic governments argue that targeted strikes carried out by UAVs are more "ethical" than strikes by inhabited aircraft because of their greater ability to conform to the principles of discrimination and proportionality (Brennan, 2012).

Armed drones also appeal to non-democracies, but the logic is different. First, non-democratic leaders are more likely than democratic leaders, on average, to worry about and encounter civil wars, insurgencies, and lower-level strife that imperils their political power and even lives (Bueno de Mesquita et al. 2004). Therefore, armed UAVs may be attractive to non-democratic leaders for their ability to conduct "remote control repression" against a leader's current and future domestic enemies (Cronin 2013, 47). For example, Turkey frequently employs armed UAVs to attack and kill members of the Kurdistan Workers' Party (PKK). Drones may also be attractive to autocrats because they can be operated from centralized locations by the leader's most loyal supporters, reducing worries about disobedience (Horowitz, 2017: 176). In sum, though democracies and non-democracies may have different *rationales* for demanding armed drones, there is little reason to expect aggregate demand for drones to differ significantly by regime type.

Regime type was also largely irrelevant during this period because neither democracies nor non-democracies, overall, had a marked advantage when it came to supply-side factors. There are significant technological, organizational, and infrastructural challenges associated with building and operating capable armed drones (Gilli and Gilli, 2016). Therefore, even though democracies tend to be richer per capita and more technologically advanced than non-democracies, supply-side constraints made it difficult for most to indigenously build armed UAVs (Gilli and Gilli, 2016). In fact, only the US and Israel successfully deployed indigenous armed drones during this period. Additionally, neither democracies nor non-democracies had an advantage in terms of buying armed drones because the existing potential suppliers were quite restrained. Israel exported zero armed drones between 1994 and 2010 (though they were a large-scale exporter of unarmed drones), and the US did so to the United Kingdom only. If the US had been more willing and able to export armed UAVs to its democratic allies, then that might have given democracies a significant supply edge relative to non-democracies. Nevertheless, the US was (and still is currently) limited in its ability to export armed UAVs by the MTCR, which subjects Category I systems to a "strong presumption of denial." Given these factors, we would expect the following hypothesis to hold:

> H1: *From 1994 to 2010, there is no significant difference between democracies and non-democracies when it comes to the probability of armed UAV pursuit or possession.*

Period II: 2011 – 2019

We further theorize that a significant supply shock in 2011 generated a new relationship between regime type and proliferation. Specifically, China's development of an armed drone in 2011 and its willingness to export this technology asymmetrically eased supply-side constraints for non-

democracies. While China claims to follow the MTCR guidelines, it is not a formal member. China also claims that its drone platforms for export, like the CH-3, CH-4, and Wing Loong, all fall slightly under the MTCR Category I guidelines (Nacouzi et al., 2018: 11-12). Thus, while the US was restricted under the MTCR, China was relatively unconstrained.[2]

We expect that non-democracies were more likely than democracies to purchase armed drones from China.[3] This is primarily because non-democracies had greater interest in buying Chinese-made technology than democracies. It is also possible that China may prefer to sell armed drones to non-democracies than democracies, but their "no-questions asked" approach to arms sales combined with structural incentives as a rising global power to expand their political influence suggests they would probably be willing to sell to democracies if given the opportunity (Li and Matthews 2017).[4] Non-democracies are more willing than democracies to buy from China for two main reasons.

First, China puts fewer end-use restrictions on the use of their military technology than democracies like the United States (Department of Defense, 2018: 5), which should be attractive to non-democracies in general since they are more likely to violate international human rights laws and principles. For example, the United States' 2015 drone export policy required recipients to "use these systems in accordance with international law, including international humanitarian law and international human rights law," and to not "use military UA[Vs] to conduct unlawful surveillance or use unlawful force against their domestic populations" (Department of State, 2015).

[2] Although Israel is not a member of the MTCR, it abides by its restrictions and has been restrained in exporting Category I systems (Nacouzi et al., 2018: 37).
[3] We aggregate autocracies and mixed regimes into a single category of "non-democracies" for parsimony and because we expect this supply shock to apply to both autocracies and mixed regimes. However, in the appendix we disaggregate non-democracies and show the results are consistent.
[4] However, China has expressed a willingness to restrict drone exports in order to prevent this technology from falling into the hands of militant groups (Blanchard, 2015). This suggests there are limits to China's "no-questions asked" policy.

And even close American allies, like France, need the permission of the US government to deploy armed MQ-9 Reaper drones imported from the United States (Nacouzi et al., 2018). Alternatively, China has adopted a "no-questions asked" approach to arms sales in accordance with their principle of "non-interference" in the domestic affairs of foreign countries (Li and Matthews 2017; Tabrizi and Bronk, 2018). As Xu Guangyu, a retired major general in in the People's Liberation Army, said, one of China's major advantages in selling arms is that they do not "make demands over other governments' status and internal policies" (Wong and Clark, 2013).

Second, for many democracies, like European members of NATO and Japan, South Korea, and Australia, acquiring armed drones from China is unattractive for strategic reasons (Wezeman et al. 2019). Just as Turkey purchasing a Russian air defense system resulted in significant censure from the US due to concerns about possible Russian espionage, buying armed drones from China might also result in blowback. Moreover, many democracies may themselves be concerned that China could use exported drones to gather intelligence, rendering purchase unattractive. Previous research also shows that path dependence is an important factor in arms sales (Thurner et al., 2019). Since many democratic countries purchased arms from the US during the Cold War, democracies should also be more likely to prefer arms imports from the US relative to China for reasons relating to inertia.

Our argument that non-democracies are more likely to import armed UAVs from China is in accordance with previous research, which finds that countries are more likely to trade arms with each other if they have similar regime types (Akerman and Seim, 2014; Thurner et al., 2019), and that this bias may be particularly strong for autocracies like China and Russia (Akerman and Seim, 2014: 538-39).[5]

[5] De Soysa and Midford (2012) come to a different conclusion, though Johnson and Willardson (2018: 3) point out there are some methodological issues with their study.

Given the relative increase in supply for non-democracies, we expect the following hypothesis to hold:

H2: *From 2011 to 2019, non-democracies should be more likely to pursue and possess armed UAVs than democracies.*

While we expect this hypothesis to hold for both pursuit and acquisition, there could be subtle differences in proliferation dynamics between the two. Supply-side factors are likely stronger correlates of acquisition than pursuit, as countries can still pursue weapons even if they face supply-side challenges to acquisition, but they cannot acquire weapons without overcoming these challenges. Thus, we might expect the Chinese supply shock to have a stronger impact on acquisition than pursuit. Nevertheless, lower supply-side barriers should still make pursuit more attractive because it increases the chances that pursuit will ultimately pay off with acquisition (see Fuhrmann 2012, 144-148).

Armed Drones as Status Symbols

A previously under-studied reason why states may demand armed UAVs relates to the status or prestige that countries receive from obtaining them. If procuring armed drones signals to international and/or domestic audiences that a country is powerful, independent, and technologically-savvy, then status-seeking states, eager to demonstrate that they "belong," may be more likely to pursue them (Wendt and Barnett, 1993). After all, armed drones are considered a cutting-edge technology that demonstrates the 21st century military capabilities of a country. Hence, states may pursue and acquire armed UAVs to enhance their reputation (O'Neill, 2006), even if they face relatively low security threats.

Previous research demonstrates that states often pursue weapons in an effort to boost their status. Farrell (2005), in a case study evaluating the pre-World War II Irish military, and Suchman and Eyre (1996), in a quantitative analysis of third-world countries, find that states often pursue advanced conventional technologies and build relatively capital-intensive militaries in order to enhance their status, even though adopting unconventional strategies would be more effective against their likely adversaries.

Several prior studies also conclude that one of the reasons states demand nuclear weapons is because they believe acquiring them will enhance their prestige (e.g., Sagan, 1996/1997), and Gilady (2018) has shown that states acquire aircraft carriers and space capabilities for a similar reason. If states pursued these kinds of weapons for status, then perhaps they demand armed drones for a similar reason. In fact, pursuing armed drones for status may be more attractive than pursuing nuclear weapons, aircraft carriers, or space capabilities. Although drones are significantly less powerful than nuclear weapons and thus less impressive to possess, pursuing nuclear weapons often entails significant international blowback in the form of severe economic sanctions and even military intervention. By contrast, pursuing and obtaining armed UAVs does not entail similar costs. Compared to aircraft carriers or space capabilities, armed drones are also much cheaper and easier to acquire, perhaps making them more attractive.

Research by Tabrizi and Bronk (2018: 39) also supports our theory. They conducted interviews with policymakers, drone manufacturers, and air force experts in the Middle East and found that "prestige and country-status seemed to be the main drivers for acquiring armed drones for all states in this study." Thus, we should expect to see more armed drone proliferation than if states only pursued armed UAVs in response to security threats.

H3: *Status-seeking countries should be more likely to pursue and possess armed UAVs than non-status-seeking countries*.

Although we believe the shocks we identify significantly changed the relationship between regime type and armed UAV proliferation, we do not believe the same holds true for status. The perceived reputation of armed drones increased throughout the entire time period, and thus there should not be period-based effects for status.

Additionally, it worth noting that demand-side factors are likely stronger correlates of pursuit than acquisition since demand alone is not enough to overcome supply-side hurdles and acquire when states face technological or financial barriers (Horowitz 2010). Consequently, we might expect status motivations to have a greater impact on the pursuit of armed drones than their acquisition. However, higher demand could still make acquisition more likely because countries will not buy or build a weapon if they do not at least have some level of desire for it.

Research Design

To test our hypotheses, we use an original time-series cross-sectional dataset that we created to measure the status of states' armed UAV programs from 1994 through 2019. In total, our dataset has over 4,300 country-year observations for 168 different countries.

Dependent Variables

We construct two primary dependent variables: Armed UAV Pursuit and Armed UAV Possession. Both are dichotomous; they are coded 1 if a country pursued armed UAVs or possesses them in a given year and 0 otherwise. Unrecoverable 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 (Schmidt and Schmitt, 2016).

Despite the normal challenges involving accurately assessing national military capabilities, we obtained detailed information about armed UAV programs from media reports and from trade publications like *IAH Jane's*. Even countries that might be thought of as secretive when it comes to military technology, like Iran and China, often like to flaunt their armed UAV technology at airshows and parades, as well as on state-owned television. The fact that states publicize their possession of armed drones actually provides additional qualitative evidence for our status argument, as acquiring a military technology cannot confer prestige internationally if foreigners do not know that a state has acquired it (O'Neill, 2006: 4-5).

Following Fuhrmann and Horowitz (2017: 408), 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;[6] (2) the government of a country has stated its intent to acquire armed UAVs in an official policy document or speech;[7] or (3) the government of a country has attempted to purchase an armed UAV.[8] We categorize countries as possessing armed UAVs if a country has either: (1) developed a functional armed UAV indigenously;[9] or (2) imported an armed UAV from a foreign producer. We provide all of the sources used to construct the dependent variables in the online appendix.

[6] For example, the joint European nEUROn unmanned combat aerial vehicle project aimed to build a technological demonstrator.
[7] For example, Canada announced its aim to acquire armed UAVs in its official 2017 defense policy document.
[8] For example, Mexico requested that the US provide it with armed drones to combat drug cartels in 2006.
[9] For example, Turkey has developed armed drones domestically.

Figure 1 maps armed UAV pursuit and possession across time. The significant increase in the number of states that possess armed drones between 2014 and 2019 demonstrates the value of our updated dataset and the need to re-examine the determinants of armed drone proliferation.

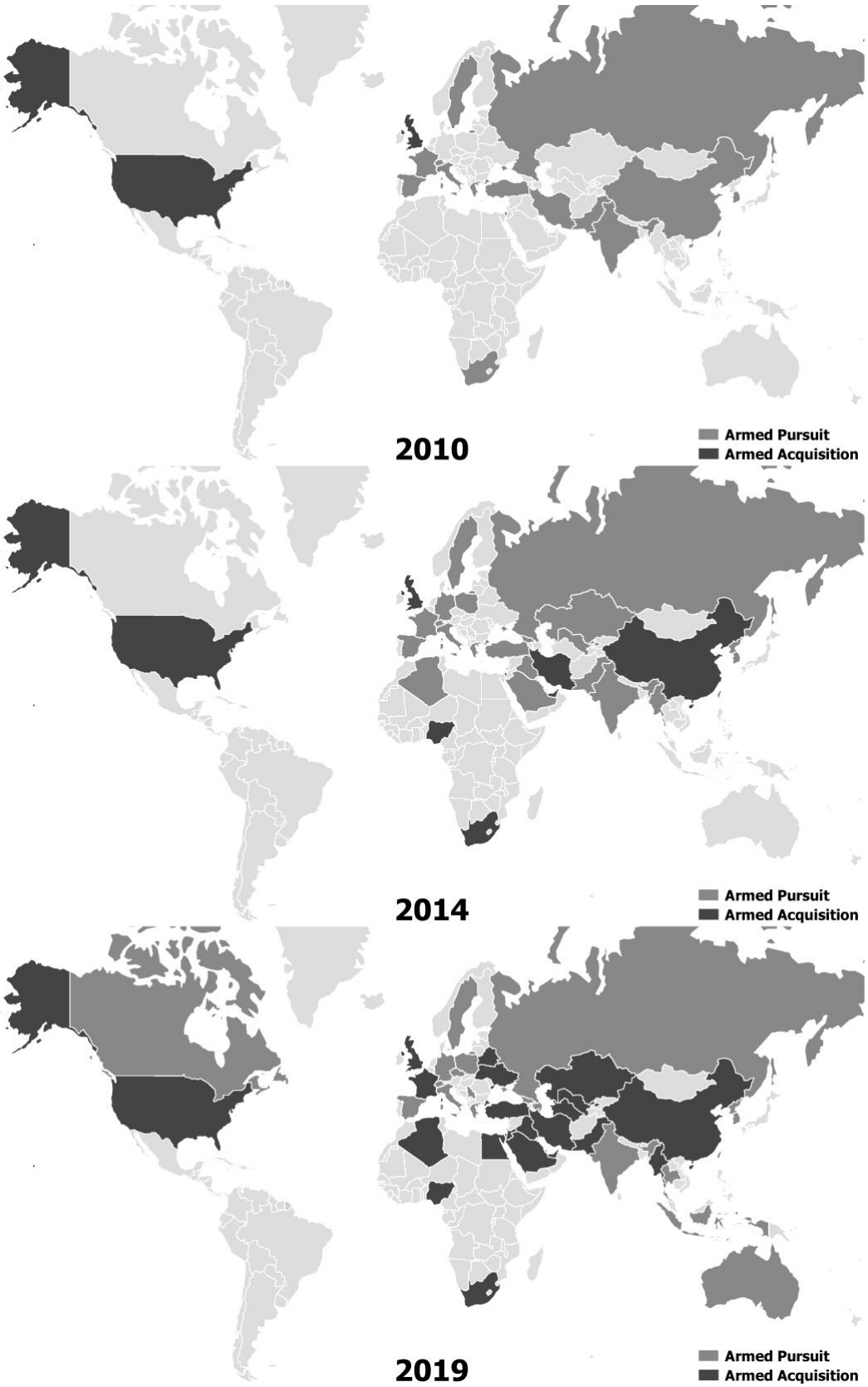

Figure 1. Armed UAV pursuit and possession over time.

Figure 2 maps which states have imported armed UAVs and who they imported from, showing the substantial increase in imports from 2010 to 2019, particularly from China. This visually demonstrates the significant difference between Period I (1994-2010) and Period II (2011-2019), and the importance of China entering the drone export market in 2011.

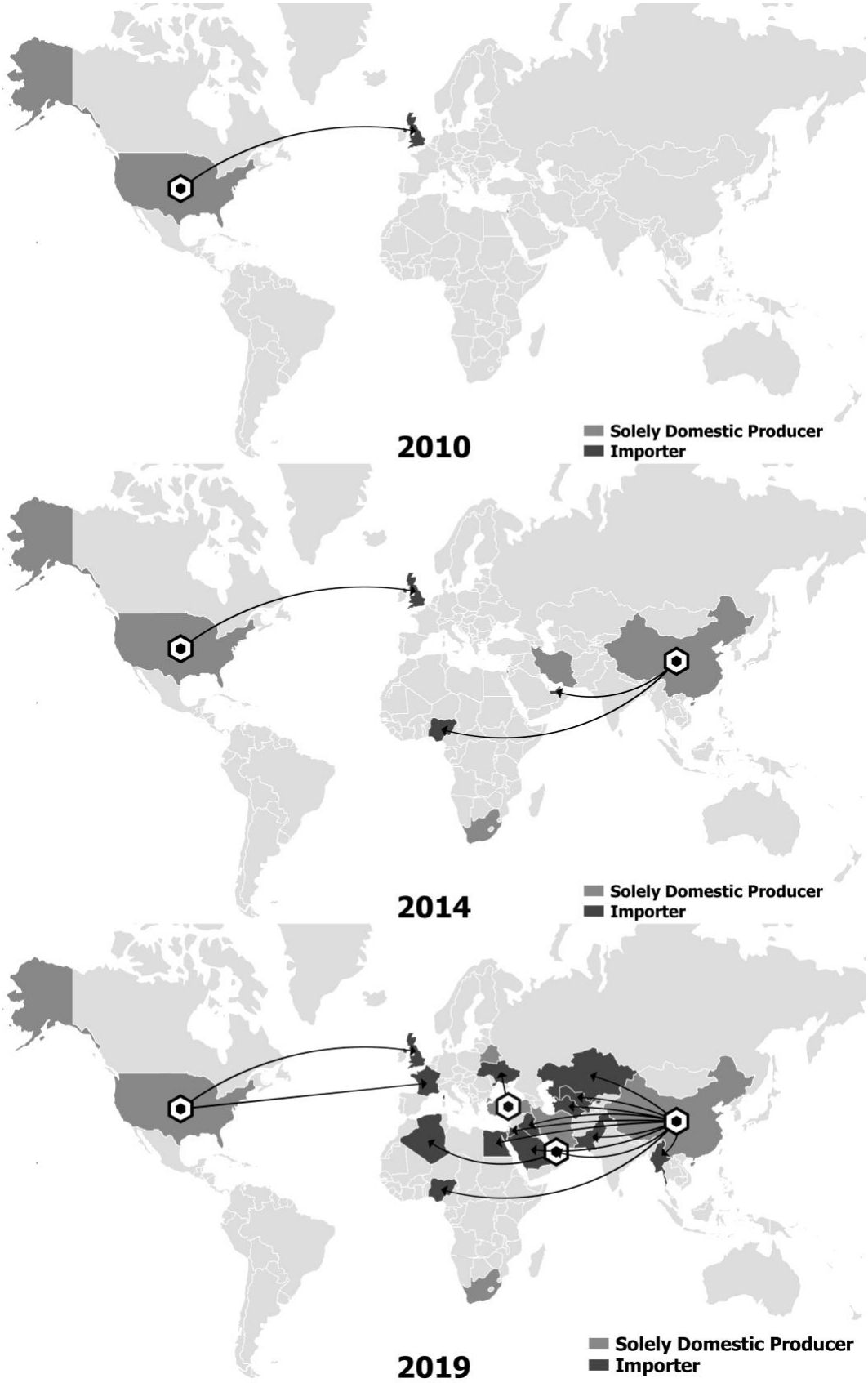

Figure 2. Armed UAV exports over time.

Independent Variables

To test our hypotheses, we operationalize our two key explanatory variables: regime type and status-seeking. To measure regime type, we create a dichotomous variable that measures whether a state is a democracy or a non-democracy utilizing the Polity IV Project's widely employed 21-point indicator (Marshall, Gurr, and Jaggers, 2014). NON-DEMOCRACY is coded 1 if a state's Polity score falls between –10 and +6 and 0 otherwise. We also show in the appendix that our results are robust to the use of a different cut-point on the Polity scale, the continuous Polity measure, and a different measure of democracy from Freedom House.

Operationalizing whether a state is a status-seeker is much more difficult. Past studies measure status-seeking using proxies that are only loosely associated with the core concept of interest. Suchman and Eyre (1996) measured status using the number of intergovernmental organizations (IGOs) a state belonged to. However, many factors besides prestige affect whether states want (and are allowed) to join IGOs. And membership in many of these organizations—for example, the Alliance Against Biopiracy or the International Grains Council—may not reflect a state's desire to enhance its international status (Renshon, 2017: 15). Jo and Gartzke (2007) operationalize status-seeking with a variable that measures whether a state is a global or regional power. However, states that are not currently major powers, but perhaps aspire to be, may also seek status in order bolster their reputation. Additionally, given that Jo and Gartzke (2007) use a state's capabilities to define whether it is a global or regional power, it is difficult to disentangle whether capabilities or status-seeking drives nuclear proliferation.

Instead, building on Rhamey Jr. and Early (2013), we measure whether states are status-seekers based on whether they over-perform at the Olympics relative to expectations based on a normal model of likely Olympic performance. Although this is also not a direct measure of the

concept, we believe that it is more closely associated with status-seeking than the alternatives. The Olympics are an ideal setting for status seekers because they are public and reveal a state's relative position (Rhamey Jr. and Early, 2013: 247-249). For these reasons, status-seeking states are often willing to invest heavily in recruiting and training their Olympic athletes in an effort to boost performance. For example, in 2008, China may have spent up to half a billion dollars training their Olympic athletes (Eimer, 2008).

Moreover, the idea that Olympic over-performance enhances a state's status is not merely theoretical. Rhamey Jr. and Early (2013) found statistical evidence that Olympic over-performance increases a state's number of diplomatic contacts. Therefore, following a procedure developed by Early (2014), we estimated the predicted number of medals a country should have won in the 1992, 1996, 2000, 2004, 2008, 2012, and 2016 Olympics. We then compare the predicted number of medals to the number of medals states actually won. Following Early (2014: 63), states are coded as status-seeking if they win at least 5 medals and the actual number of medals is at least twice as large as the predicted number of medals.[10] As a robustness check, we also show that our results hold when we use an alternative measure of status from Renshon (2016), which measures whether states face a status deficit globally or compared to their relevant status community.[11] Empirical tests also support that there are not period effects to status. There is no correlation between regime type and status,[12] so the most important shock we identify—China's emergence as a viable supplier—has no clear connection to the status of armed drones.

[10] We also show in the appendix that our results are robust to the use of two less strict coding rules. The first alternative specification eliminates the 5-medal requirement so as not to bias against small countries. The second codes a state as status-seeking if their actual number of medals is greater than their predicted number of medals, which avoids biasing against larger countries that have a high number of expected medals.
[11] We extend Renshon's (2016) measure of status through 2005 using updated CINC data and forward-fill the remaining values.
[12] The Pearson's correlation coefficient between our main measure of regime type and status is just 0.03.

In our main models below, we control for other variables that also likely shape armed drone proliferation and may also be correlated with regime type and status-seeking:[13]

- TERRORISM: The logged number of terrorist attacks a country experienced per year, according to the Global Terrorism Database. Results are also robust to a measure of deaths from terrorist attacks, as well as 3 and 5 year averages of these two variables.
- INTERSTATE THREATS: The number of interstate rivals a country has, according to updated data by Goertz, Diehl, and Balas (2016). Our results are also robust to the use of a variable that measures the total number of states with whom a country shares a border (Stinnett et al., 2002) and the number of militarized interstate disputes a state was involved in, on average, over the past 3 or 5 years (Palmer et al., 2015).[14]
- GDP PER CAPITA: The log of a state's GDP per capita, according to the World Bank, which proxies a state's technological capacity.

In the appendix, we also demonstrate our results hold when controlling for whether a state has an alliance with the United States (Leeds et al. 2002) and the absolute difference in United Nations voting ideal points between a country and the United States (Bailey, Strezhnev, and Voeten, 2017). This suggests that regime type has an effect independent of alliances and foreign policy preferences.

Estimation Strategy

We employ hazard models to analyze the determinants of armed UAV pursuit and possession.[15] These models examine the risk, or hazard, that some event will occur. The "hazard," in our case,

[13] All independent variables, except the borders proxy, are lagged one year to reduce concerns about potential endogeneity.
[14] Data are forward-filled for missing years.
[15] This is consistent with Singh and Way (2004) in the nuclear proliferation literature.

is whether a state has pursued or acquired armed UAVs. Once a state pursues or acquires armed UAVs, it exits the data since it has already succumbed to the hazard and is no longer at risk. The main advantages of utilizing hazard models are that they explicitly model the effects of time and they account for right-censoring, or the fact that most states have not pursued or acquired armed UAVs by 2019 (Box-Steffensmeier and Jones, 1997). Our main models utilize a Weibull distribution to characterize the baseline hazard function. In the appendix, we demonstrate that our results are robust to different specifications, including Cox models, logistic models that control for time dependence (Carter and Signorino, 2010), and alternative measures of our independent variables.

Results

Table 1 contains the results from six different models with robust standard errors clustered by country. Models 1-3 focus on the pursuit of armed drones, and models 4-6 focus on the possession of armed drones. To ease interpretation, we report hazard ratios instead of traditional coefficient estimates. Hazard ratios are interpreted relative to 1, where hazard ratios greater than 1 imply that a variable is increasing the risk of armed UAV pursuit or possession, and hazard ratios less than 1 suggest that a variable is decreasing the risk of armed UAV pursuit or possession. For example, a binary variable with a hazard ratio of 2 doubles the risk of armed UAV pursuit or possession, while a variable with a hazard ratio of 0.5 halves the risk.

Table 1. Survival Analysis of Armed UAV Proliferation

	(1) Pursuit	(2) Pursuit	(3) Pursuit	(4) Acquisition	(5) Acquisition	(6) Acquisition
Non-Democracy (All Years)	1.778*			5.306***		
	(0.566)			(3.143)		
Non-Democracy (Before China Shock)		0.568			0.904	
		(0.288)			(1.127)	
Non-Democracy (After China Shock)			4.241***			8.281***
			(2.025)			(6.106)
Status-Seeking	3.415***	3.951***	3.951***	0.631	0.652	0.652
	(1.149)	(1.366)	(1.366)	(0.633)	(0.633)	(0.633)
Terrorism	1.499***	1.461***	1.461***	1.347***	1.330***	1.330***
	(0.109)	(0.106)	(0.106)	(0.134)	(0.133)	(0.133)
Interstate Threats	1.312***	1.352***	1.352***	1.565***	1.532***	1.532***
	(0.107)	(0.116)	(0.116)	(0.257)	(0.214)	(0.214)
Logged GDP Per Capita	2.034***	2.047***	2.047***	1.845***	1.833***	1.833***
	(0.247)	(0.245)	(0.245)	(0.287)	(0.290)	(0.290)
Non-Democracy X Period 2		7.472***			9.159	
		(5.183)			(12.53)	
Period 2		0.219**			0.300	
		(0.170)			(0.303)	
Non-Democracy X Period 1			0.134***			0.109
			(0.0928)			(0.149)
Period 1			4.558**			3.335
			(3.525)			(3.375)
Constant	3.90e-08***	1.44e-08***	3.17e-09***	2.44e-11***	8.51e-11***	2.55e-11***
	(6.19e-08)	(3.86e-08)	(1.03e-08)	(6.04e-11)	(2.50e-10)	(8.96e-11)
Ancillary Parameter (p)	2.563***	3.096***	3.096***	4.616***	4.539***	4.539***
	(0.421)	(0.905)	(0.905)	(0.772)	(0.889)	(0.889)
Observations	3826	3826	3826	4086	4086	4086
AIC	157.6	151.2	151.2	79.21	80.44	80.44
BIC	201.4	207.5	207.5	123.4	137.3	137.3

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

Regime Type and UAV Proliferation

In order to analyze the effect of regime type on armed drone proliferation, we begin by examining models 1 (pursuit) and 4 (possession).[16] These models show that non-democracies are more likely than democracies to pursue and acquire armed drones. However, models 1 and 4 test whether non-democracies were significantly more likely to pursue and possess armed drones throughout the *entire* time period and are therefore misleading because they fail to account for the supply shock of China entering the armed drone export market in 2011.

[16] In accordance with Fuhrmann and Horowitz (2017), we find that autocracies are more likely to pursue and acquire armed drones than mixed regimes. However, in contrast to their results, we find that democracies are less likely to acquire armed UAVs than mixed regimes. See the appendix for more details.

We now examine whether the effect of regime type changes over time by including interaction terms to isolate the effect of non-democracy in the two periods of interest. H1 expects that NON-DEMOCRACY will not be statistically significant before the Chinese supply shock (1994-2010), while H2 holds that NON-DEMOCRACY should be statistically significant and greater than 1 after the Chinese supply shock (2011-2019). In the appendix, we show that the results below are also robust to subsetting the data into these two periods instead of utilizing an interaction term approach.

Starting with pursuit, we find evidence in support of both hypotheses. Consistent with H1, NON-DEMOCRACY does not have a statistically significant effect on armed drone pursuit before the Chinese supply shock (model 2). However, in accordance with H2, non-democracies were significantly more likely to pursue armed UAVs than democracies after the Chinese supply shock (model 3). Moreover, this result is substantively significant, as non-democracies were over four times more likely to pursue armed drones than democracies after China entered the armed drone export market.

As a graphical illustration of the effect of regime type after the Chinese supply shock, Figure 3 plots the survival curve for the pursuit of armed drones based on regime type. The y-axis represents the probability of survival (i.e., not pursuing armed drones) past year *t*, conditional on survival until year *t*. Figure 3 illustrates that non-democracies were at greater risk of pursuing armed drones than democracies from 2011 to 2019.

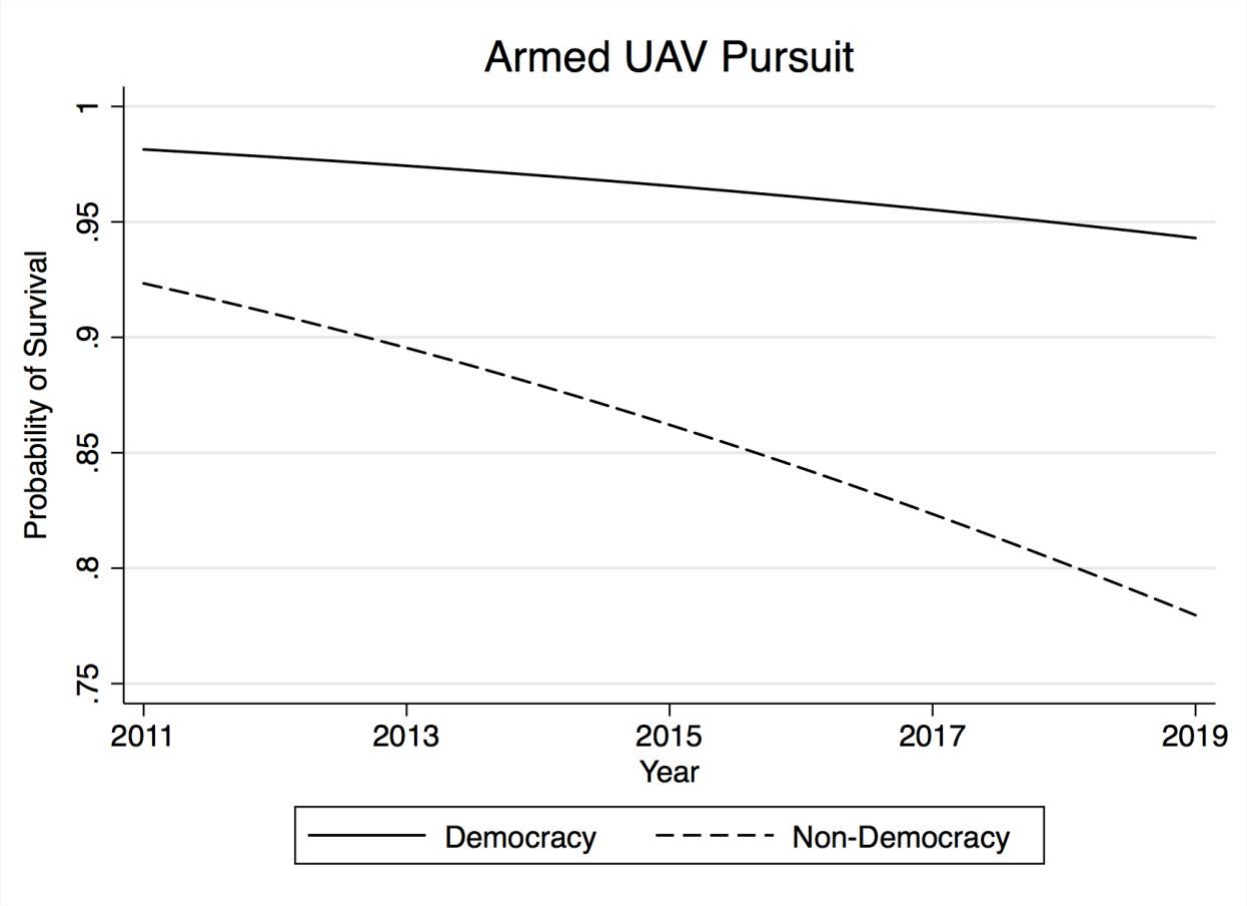

Figure 3. Survival curve for armed drone pursuit.

We also find evidence for our hypotheses when it comes to armed drone possession. NON-DEMOCRACY does not achieve conventional levels of statistical significance before the Chinese supply shock (model 5), indicating that regime type does not help us distinguish between adopters and non-adopters of drones from 1994 to 2010. This finding is consistent with H1, but we must be circumspect when interpreting this evidence. Only 3 countries—the US, Israel, and the UK—obtained armed drones during this period. Based on its polity score in the year that it first obtained an armed drone, Israel just misses the cut for being classified as a democracy (it is coded as a 6). If we instead classify Israel as democratic, all of the states that obtained armed drones from 1994 to 2010 would be democracies. In any case, this pattern shifts markedly during the second phase

of drone proliferation. After the Chinese supply shock (model 6), non-democracies were significantly more likely to acquire armed UAVs than democracies. The substantive size of this effect is large: non-democracies were over *eight* times more likely to acquire armed drones than democracies from 2011 to 2019. That regime type is a stronger predictor of acquisition (model 6) than pursuit (model 3) suggests that supply-side factors may be stronger determinants of acquisition than pursuit, in accordance with our previous discussion. As before, the results are similar when we divide the dataset into two periods. Figure 4 plots the survival curve for the possession of armed drones based on regime type. It visually demonstrates that non-democracies were at greater risk than democracies of acquiring armed drones from 2011 to 2019.

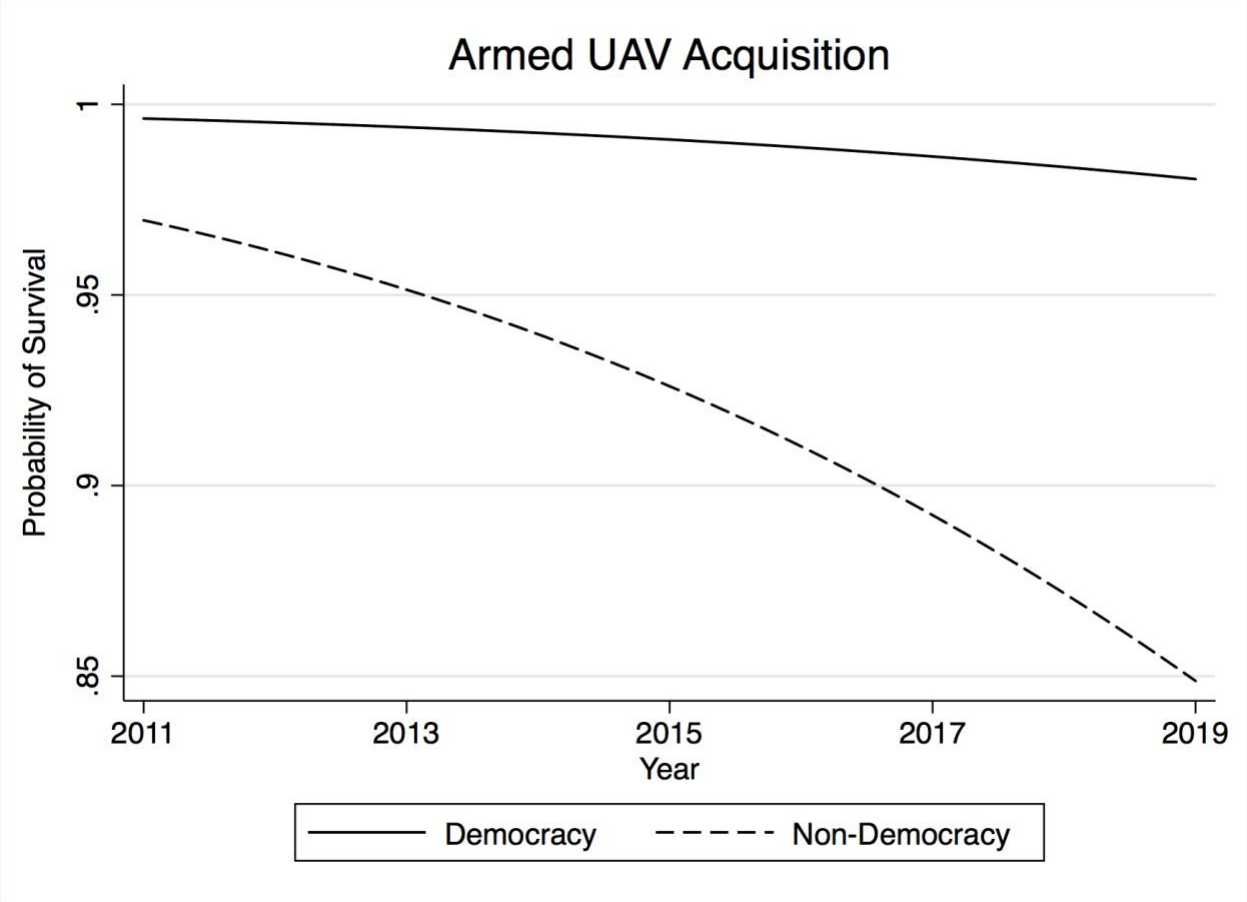

Figure 4. Survival curve for armed drone possession.

A qualitative look at the data also makes it clear that there are stark differences in the regime types of armed UAV adopters in the two eras. The early adopters were countries that most people would recognize as democracies (see table A16 in the appendix). At most, 33% of the states that obtained armed drones from 1994 to 2010 were non-democratic. By contrast, 15 of the 19 countries—almost 80%—to field armed drones from 2011 to 2019 were non-democracies in the first year of possession. In large part, this pattern can be explained by China's emergence as a key armed UAV exporter. At least as early as 2011, China started negotiating with countries like the UAE and Pakistan to sell them armed UAVs (Wan and Finn, 2011). Since then, China has dominated the export market for armed UAVs. Of the 18 countries that have acquired armed drones since 2010 (not including China), 11 have bought from China.[17] Therefore, while most democracies could not turn to the US to provide them with armed drones due to the MTCR, China was more than willing to sell armed UAVs to non-democracies with questionable human rights records like Saudi Arabia, Egypt, Uzbekistan, and others. This supply shock, as predicted, thus made non-democracies more likely to acquire armed drones than democracies.

Imports from China and Armed Drone Proliferation vs. Drone Proliferation in General

To test the logic of our regime type hypotheses more directly, we conduct two additional analyses. The relevant results are displayed in Table 2.

First, in model 1, we analyze the determinants of importing armed drones from China. Evidence that non-democracies are more likely to buy technology from China would increase confidence that the causal mechanism at the heart of our argument accounts for the pattern we observed previously. However, if there is not such a relationship, other explanations would better

[17] The 11 countries are the UAE, Nigeria, Saudi Arabia, Egypt, Iraq, Pakistan, Uzbekistan, Jordan, Kazakhstan, Myanmar, and Turkmenistan.

explain why non-democracies are especially likely to pursue and obtain armed drones since 2010. In this analysis, we include all of our main control variables, in addition to factors that may specifically affect imports from China like physical distance between capitals (Gleditsch and Ward, 2001), trade dependence on China measured as imports from China as a share of a state's total trade (Barbieri, Keshk, and Pollins, 2009),[18] and the absolute difference in United Nations voting ideal points between a country and China (Bailey, Strezhnev, and Voeten, 2017).

The results support our theoretical argument: non-democracies are over *seven and a half* times more likely to import armed drones from China than democracies, even when controlling for a range of possible factors. Moreover, in the appendix, we show that our broader finding that non-democracies are more likely to acquire armed UAVs after 2010 disappears if we exclude countries that imported from China. In combination, these two results suggest that the supply shock of China entering the armed drone export market in 2011 is the primary factor driving our regime type findings.

Second, in model 2, we analyze the determinants of acquiring military drones in general––not just armed drones—using data from Gettinger (2019).[19] The results suggest that non-democracies are not reliably more likely to acquire military UAVs after the Chinese supply shock in 2011. If anything, they were actually *less likely* to acquire military drones after 2011. This result is in stark contrast to our analysis of *armed* drone proliferation, suggesting that the causes of armed and unarmed drone proliferation can differ under certain circumstances and so studying them separately can be productive. Specifically, the null finding in model 2 is consistent with our argument that some countries—like the United States and Israel—are more hesitant to sell armed drones compared to unarmed drones, while China is not.

[18] This data only goes through 2014, and so the remaining years are forward-filled.
[19] Specifically, any state that has acquired a "Class I" military drone according to Gettinger (2019) is coded as a 1.

Table 2. Imports from China and UAV Proliferation in General

	(1) Armed UAV Imports from China	(2) General UAV Acquisition
Non-Democracy (After China Shock)	7.633*	0.763
	(8.483)	(0.289)
Status-Seeking	0.823	2.895***
	(0.901)	(0.831)
Terrorism	1.533**	1.481***
	(0.271)	(0.0909)
Interstate Threats	0.746	1.333***
	(0.292)	(0.0931)
Logged GDP Per Capita	1.824**	1.782***
	(0.523)	(0.146)
US Ally	0.479	1.442
	(0.499)	(0.361)
Distance from China	1.000	
	(0.000189)	
Trade Dependence on China	73.07	
	(236.3)	
Difference in UN Ideal Point from China	0.346	
	(0.305)	
Non-Democracy X Period 1		1.284
		(0.620)
Period 1		0.518*
		(0.181)
Constant	0.00000284***	0.0000398***
	(0.0000112)	(0.0000394)
Ancillary Parameter (p)	1.910***	1.415***
	(0.276)	(0.152)
Observations	1322	3019
AIC	82.67	302.9
BIC	139.7	363.0

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

Status-Seeking and UAV Proliferation

Going back to our main analysis in Table 1, the status-seeking results clearly demonstrate how the symbolism of UAVs shapes national behavior. We find strong statistical evidence ($p < 0.01$) across

Models 1-3 that status-seeking states are more likely to pursue armed UAVs than non-status-seeking states, even when controlling for security incentives states might have to pursue armed drones. This variable is also substantively significant. Model 1 estimates that being a status-seeking country more than triples the risk of pursuing armed drones. Kazakhstan, Uzbekistan, Russia, and North Korea are among the status-seeking countries that have pursued armed UAVs. The fact that Kazakhstan and Uzbekistan faced relatively low interstate and terrorism-related security threats when they started pursuing armed drones provides additional suggestive evidence that status concerns may have been a factor in their pursuit of these weapons. Furthermore, after acquiring armed drones from China in 2016, Kazakhstan has not carried out any drones strikes, but did show off their advanced technology in a 2017 parade commemorating the 25th anniversary of the founding of the Kazakh armed forces (Dominguez and Gibson, 2017). In the appendix, we also show that this result is robust when we utilize an alternative measure of status from Renshon (2016).

However, while status-seeking may drive the pursuit of armed drones in some cases, there is not a statistically significant correlation between status-seeking and armed drone possession in our main models (though the correlation does become significant when using the Renshon (2016) measure). Perhaps this is due to the fact that demand-side factors are likely stronger correlates of pursuit than acquisition since demand alone is not enough to overcome supply-side hurdles and acquire. Nevertheless, given that we are still in the early adoption period of armed drone proliferation, future studies should test the effect of status-seeking on armed drone possession when more data is available.

Other Findings

The control variables behave as expected and are generally consistent with Fuhrmann and Horowitz (2017). Terrorism within a country is significantly and substantively associated with both pursuit and possession. For example, Model 4 suggests that a one standard deviation increase in the number of terrorist attacks increases the chance of armed UAV possession by over 60%. In the appendix, we also replace TERRORISM in Models 1 and 4 with a variable that measures the yearly logged number of national battle-related deaths from an intrastate conflict (Allansson, Melander, and Themner, 2017), or the Political Terror Scale, which measures violations of human rights by agents of a state (Gibney et al., 2017). Our findings reveal that states that face greater intrastate threats and are more egregious violators of human rights are significantly and substantively more likely to pursue and possess armed UAVs. These results imply that Cronin's (2013: 47) concern about armed drones being used for "remote control repression" may have been well justified.

We also find that a state's technological capacity, as proxied by GDP per capita, is a statistically and substantively significant determinant of armed drone proliferation. Model 4 implies that a one standard deviation increase in GDP per capita increases the chance of armed UAV possession by over two and a half times.

Unlike Fuhrmann and Horowitz (2017), we consistently find that states that face greater interstate security threats should be more likely to pursue and possess armed UAVs. Their null finding may be due to the fact that they used a relatively narrow measure of interstate threats as their main measure: territorial disputes. However, armed UAVs may help states manage a broader array of threats. Our main measure— the number of interstate rivals a country has—captures many territorial disputes countries are involved in, but also other types of disputes and long-term

conflicts. As a standard realist model would predict, countries that have a greater number of interstate rivals are significantly more likely to pursue and possess armed drones.

Predicting Future Proliferation Risks

Like Fuhrmann and Horowitz (2017), we identify the states that are most likely to pursue and/or acquire armed UAVs in the future, based on the estimates from Models 1 and 4. A few predictions stand out. First, Russia's high probability of possession is unsurprising. They have been developing armed drones for several years now and will likely have a deployable armed UAV in the near future. Second, the presence of many Middle Eastern countries on this list makes sense given the serious internal and external security threats that they face. Third, the presence of some countries on these lists—like Japan, Ireland, and New Zealand—is surprising because we would generally expect these states to have a low likelihood of pursuing and acquiring armed drones. The primary reason for their inclusion is that these countries have a high GDP per capita, which is a strong correlate of proliferation in our models, as well as Fuhrmann and Horowitz's (2017). For example, Fuhrmann and Horowitz's (2017, 414) models suggested that Ireland had the *greatest* probability of acquiring armed drones by the end of 2014. Nevertheless, these unexpected results may suggest that our models are overemphasizing the importance of technological capacity relative to other factors. Finally, it is interesting that some countries—like Japan—have a greater probability of pursuing than acquiring armed drones according to our models. This is primarily because being a democracy is associated with a lower chance of acquisition relative to pursuit in our models, meaning that Japan—a democracy—may face particularly significant supply-side barriers to acquiring, whereas pursuit is an easier threshold to cross.

Table 3. Likely Candidates for Future Armed UAV Proliferation

Type of Proliferation	Country	Probability of Proliferation Past 2019
Pursuit	Thailand	0.82
	Japan	0.78
	Libya	0.76
	Colombia	0.64
	Ireland	0.63
	Bahrain	0.56
	Singapore	0.56
	Lebanon	0.54
	New Zealand	0.52
	Kuwait	0.47
Possession	Russia	0.89
	Thailand	0.60
	Libya	0.59
	Sudan	0.42
	Singapore	0.41
	Japan	0.38
	Lebanon	0.35
	Qatar	0.33
	Bahrain	0.33
	Yemen	0.31

Conclusion

Modern UAVs are a critical emerging technology whose spread has the potential to influence international politics in contexts ranging from counterterrorism (Johnston and Sarbahi, 2016; Mir and Moore, 2019) to interstate conflict (Horowitz, Kreps, and Fuhrmann 2016; Lin-Greenberg, 2019; Zegart, 2020). Armed drones have spread rapidly over the last five years, producing interesting variation in the adoption of this military technology over time. This study builds on prior work addressing the causes of drone proliferation (Fuhrmann and Horowitz 2017) by carrying out the first time-series analysis that addresses armed UAV possession and pursuit. Our findings advance knowledge about the proliferation of military technologies and carry implications for real world policies, like drone exports.

We find that a state's domestic political institutions affect UAV proliferation, but this effect has changed over time. Taking Sagan (2011) seriously and analyzing the impact of shocks in time produces valuable insights. In the first period of armed drone proliferation (1994-2010), regime type was largely irrelevant. In the second period (2011-2019), by contrast, non-democracies became more likely to pursue and possess than democracies, mostly because China entered the armed drone export market while the US was restricted by the MTCR. That the prototypical drone proliferator in recent years has been non-democratic could shape how drones are used in the future. Although many in the US may still view drones as an effective counterterrorism tool, non-democracies might be willing to use them in even more controversial ways—including domestic monitoring and repression. Given these findings, future research on proliferation should not assume that supply and demand-side factors are constant across time and that regime type only affects the demand for military technologies.

Our findings concerning regime type also contribute to real world debates about export controls on technologies such as drones. China is not a member of the MTCR and has exported armed UAVs to almost any willing buyer. Consequently, US adherence to the MTCR's restrictions on drone exports is not preventing the proliferation of armed drones to the most dangerous countries. Instead, US drone export policy has, unintentionally, put democratic countries at a disadvantage since most democracies are unwilling or unable to purchase from China. Moreover, existing export restrictions give China a strategic advantage over the United States by allowing them to cultivate defense ties with purchasing countries, including US partners like Egypt and Jordan. Our findings also, therefore, contribute to the literature on the unintended consequences of arms control agreements (Levine and Smith, 2000; Moore, 2010; Mattiacci and Jones, 2016).

We also show that security incentives, while important, are not the only demand-side factors that affect proliferation. Status-seeking states are also more likely to pursue armed drones, which suggests that they are viewed by some states as symbols of power and sophistication. This builds on prior status-seeking work on military technologies by Suchman and Eyre (1996), Farrell (2005), and Gilady (2018), among others. The results demonstrate that even military technologies that are not as powerful and expensive as nuclear weapons and aircraft carriers are still seen by some states as prestige-enhancing (Gilady, 2018). In fact, states may relish the opportunity to purchase prestige on the cheap, if possible. Moving forward, our model suggests that armed UAV proliferation specifically may occur more frequently than a standard realist model based solely on security threats would predict. Overall, these findings about regime type and status illustrate that understanding the causes of armed drone proliferation are a critical topic for policymakers as well as academics.

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