Mostly Deterred:

An Episodic Analysis of The Israel-Gaza Conflict

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Does violent retaliation to attacks by state and non-state actors lead to deterrence or, on the contrary, to counter-retaliation and protracted violence? We study this question in the context of Israel's conflict with Gaza between 2007 and 2014, using original security reports from the United Nations. We build an original dataset including over 16,000 Palestinian projectile launches and over 8,800 Israeli airstrikes, recorded with precise timing. Our findings weigh heavily against the argument that retaliation perpetuates this conflict. The conflict is characterized by short-lived episodes of violence separated by quiet interludes. Episodes tend to last less than one day and are followed by 3.5 days of calm, on average. Most episodes have no retaliation: 61% are one-sided, consisting only of provocations that go unanswered. Among episodes that do, the median number of successive counter-retaliations is only 3. Moreover, counter-retaliation does not induce subsequent episodes: 91% of episodes are initiated by Gazan militants' attacks and 85% of episodes end with Gazan militants' attacks. We find that Israeli retaliation strongly correlates with Gazans' initial number of attacks and type of rockets fired. Yet, rather than provoking an immediate increase in violence or de-escalation, retaliation seems to have no short-term effect, as would be predicted by a model of long-term deterrence.

Keywords: Cycles of violence; Deterrence; Israel – Gaza conflict;

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1. Introduction

Israel dismantled its civilians' settlements and withdrew its military forces from inside the Gaza Strip in the summer of 2005. At the time, and since 2001, Palestinians militants launched mortars and rockets against Israeli localities within and around the Gaza Strip. Israeli policymakers argued that it would be possible to deter Palestinian factions without a constant military presence on the ground. They claimed that retaining control over Gaza's borders and air space, as well as applying military force and exacting a high cost on Palestinian society in the aftermath of attacks against Israel, would be enough to deter future attacks (Evron, 2005).

After over 20,000 projectile attacks from Gazan militants and almost 10,000 airstrikes by the Israeli Air Force (IAF) against Gazan targets, this study raises the obvious question: Does retaliation against attacks deter state and non-state actors from regularly projecting violence across borders, or rather leads to counter-retaliation and an escalation of violence? The answer to this question is critical not only in the Israeli-Palestinian context, but for other conflicts around the world. For example, the Yemeni government faces a similar dilemma when it has to decide whether to use American drones to bomb Al-Qaeda operatives in Hadramawt Desert, as does the Indian government when it has to choose how to respond to Naxalite violence.

For politicians and policymakers wishing to minimize future violence and seeking to ensure national security, a same basic tradeoff arises: On the one hand, retaliating to attacks may deter future aggression by attaching a price tag (Schelling, 1966), or by reducing capacity. On the other, retaliations may provoke deadly counter-reprisals or 'blowback' (Johnson, 2000). Even though violence may originate from substantive grievances, it may subsequently take on a life of its own, feeding off of itself and become cyclically self-perpetuating. The 'cycle of violence' argument is sometimes used to explain patterns of violence in the Israel-Palestine conflict, one of the longest standing contemporary conflicts.

This paper studies the effectiveness of retaliation focusing on the protracted Israel-Gaza conflict. Our analysis relies on daily original security reports from the United Nations on violent incidents in Gaza between 2007 and 2014. We exploit natural language parsing (NLP) techniques to extract all Palestinian projectile launches (over 16,000 mortars, Qasaam and Grad rockets) and Israeli airstrikes (over 8,800), which are recorded at remarkable accuracy: down to five-minute intervals. Outside of major Israeli ground operations in the Gaza Strip, these cross-

border aerial attacks are the most frequent and publicly salient exchanges of violence, and account for the vast majority of fatalities (though only a minority of airstrikes and projectile launches are lethal). We supplement these data with weekly Israeli counter-terrorism reports (2009-2016). All told, our data span 111 months of conflict.

Using a subset of reprisals explicitly linked to earlier provocations, we find that it usually takes both sides at most 48 hours to retaliate to attacks. We use this upper bound to cluster violent incidents into episodes, where episodes are separated from each other by at least two days of quiet.[1] (To check robustness, we alternatively define episodes by longer periods of calm.) There are 312 violent episodes during the period at issue. We focus on these episodes to analyze the observed patterns of attacks, retaliations, and counter-retaliations. We also analyze how episodes start after periods of calm, escalate, de-escalate, and end.

The results of our analysis show that violent attacks between Israel and Gazan militants exhibit an episodic pattern, in which projectiles and airstrikes are exchanged in brief skirmishes which tend to last less than one day, separated by over three days of quiet. Over 90% of violent episodes are started by Gazan militants, and almost 85% of them end with a Gazan militants' attack. 59% of episodes consist of Gazan projectile attacks without an Israeli response, while only 2% of episodes consist of Israeli attacks without a Gazan response. These facts weigh against the hypothesis that retaliation induces subsequent episodes. If it did, we would expect the final barrage of the previous episode to provoke the opponent to initiate the next episode.

When interpreting these results, it is important to bear in mind that our analysis focuses exclusively on projectiles and airstrikes. While these episodes of aerial attacks constitute the lion's share of violence in Gaza, they should be properly interpreted as the product of other background processes. The Israeli-Egyptian blockade of the Gaza Strip, withholding of tax revenues to Hamas, or the construction of tunnels into Israeli territory are all actions that, though non-violent, nevertheless generate ambient levels of grievance that might plausibly provoke projectile attacks and airstrikes. Similarly, rivalries between various militant groups within the Gaza Strip are another widely noted motive for attacking Israel. Thus, the factors that kick off an episode of Israeli-Gazan aerial exchanges are generally non-cyclical and non-violent in the literal sense. The research question at hand, therefore, is restricted to whether retaliations to attacks

[1] This method is similar to clustering according to the 'nearest neighbor search,' commonly used in computer science. See, for example, Knuth (1973).

lead to counter-retaliations and an escalation of violence, or on the contrary deter further attacks. In that regard, our results suggest that if retaliation leads to the escalation of violence, it is entirely intra-episodic.

We fully characterize violent episodes into six different types. An initial attack by Gazan militants (i) may go unanswered; (ii) may lead to an Israel retaliation that goes unanswered by Gazan militants; (iii) or may lead to a cyclical episode whereby an initial attack is met with a retaliation that leads to counter-retaliations and an escalation of violence. The same three possibilities exist for episodes that start with an Israeli attack.

Our analysis shows that an Israeli retaliation to an initial aggression by Gazan militants is likely to lead to a cyclical episode, as Gazan's counter-retaliate 81.2 percent of the times to Israeli retaliations. We also observe that episodes with an Israeli retaliation tend to last longer and to include more barrages of attacks than do episodes without retaliations. Moreover, the probability that Gazan militants launch longer range and more precise rockets increases after an Israeli retaliation. Importantly, retaliation does not lead to substantially longer periods of calm in the aftermath of an episode. All of the above suggests that Israeli retaliations do not lead to the immediate de-escalation of violence within an episode nor do they deter future violent attacks for longer periods of time. That said, violent escalations after retaliations are limited, as most episodes with an Israeli retaliation last less than a week and have less than 5 alternating attacks.

We analyze the characteristics of episodes in the immediate aftermath of each type of episode mentioned above to study the protracted effects of retaliations. This analysis shows that retaliations do not immediately reduce further attacks within or between episodes, nor do they affect Israeli or Gazan militants' strategies in future episodes. Israeli retaliations appear to be a form of punishment for past levels of violence rather than a tactic to achieve future deterrence. The severity of the initial disturbance caused by Gazans' attacks (proxied by the barrage of attacks and type of munition used) within an episode are significant determinants of the Israeli decision to retaliate.

Our results show that Israel's policy of retaliation is not effective according to rational deterrence theory (Shelling, 1966). Israeli retaliations do not persuade Gazan militants that the costs of further attacks outweigh their benefits, as expected when deterrence is effective (Sobelman, 2017). Gazan militants not only counter-retaliate immediately to Israeli retaliations,

they also tend to start new violent episodes three or four days after the previous episode ends, regardless of whether or not the previous episode included an Israeli retaliation.

Given Gazans' grievances and demands, full deterrence does not appear to be an achievable outcome. We argue that Israel's policy of retaliation is effective given that constraint. This policy is consistent with the strategy developed by the theory of deterrence by proxy (Berman et al., 2019). Accordingly, larger Gazans' attacks are met with larger Israeli retaliations and punishments. Although this strategy cannot deliver general deterrence, it is effective at achieving narrow deterrence. This refers to the ability to manage an active conflict by deterring certain forms of violence (Freedman, 2004). Narrow deterrence allows Israel to set some rules to the violent confrontations, whereby it is able to impose some limitations to the type of munition used by Gazan militants and the intensity and targets of their attack.

Our analysis complements the extant empirical literature on the Israeli-Palestinian conflict. Most of the related studies relied on a vector auto-regression (VAR) framework, which allows for causal feedback between actions and reactions. Applying a VAR methodology to fatalities data from the Second Palestinian Uprising (2000-2005), Jaeger and Paserman (2008) find that Israel retaliates against Palestinian attacks, but Palestinians do not counter-retaliate. Haushofer et al. (2010) also apply a VAR framework to fatalities data augmented with Palestinian rocket launch incidents, finding that both sides retaliate. Dugan and Chenoweth (2012) run VAR-like regressions using different data, finding evidence that Palestinians retaliate while Israeli actions are apparently unprovoked. Relying on a VAR approach allows the studies above to determine whether Israelis, Palestinians, or both sides are retaliating against each other.

We imitate the VAR analysis conducted by the studies above using our data. This analysis delivers results similar to those of Haushofer et al. (2010). VAR suggests that Israelis and Gazans react in a significant and positive way to an attack by the other side. This implies that retaliations lead to blowback and escalations of violence. According to VAR, both sides are trapped in a self-perpetuating cycle of violence. This contrast with the episodic analysis, which shows that violence occurs in short episodic bursts, mostly unrelated to each other by a provocation and retaliation logic.

The different conclusions of the two methodologies highlight the advantages of an episodic analysis over a VAR or VAR-style framework. VAR correctly assesses whether Israelis, Gazans, or both sides retaliate within episodes. Yet, we show that VAR suffers from an aggregation

problem, and tends to infer spurious retaliations across episodes even when they do not exist. Hence, VAR runs the risk of incorrectly drawing causal linkages and creating a false sense of continuity and cyclicality even when there is none. As such, it may be useful in other settings to complement a VAR analysis with the type of episodic analysis we use here, to fully understand the evolution of violence in episodic conflicts.

2. Data

Militant Palestinian groups have been launching rockets and mortars from the Gaza Strip onto Southern Israel since 2001.[2] These attacks intensified after the Israeli disengagement from Gaza in 2005, and especially after the Islamic Resistance Movement (Hamas) took control of the Gaza Strip by force in 2007. Projectile attacks became since then militants' main tactic to fight against Israeli policies while overriding the security barrier built by Israel along the Gaza Strip. According to the Israeli Security Agency, Gazan militants launched over 20,000 projectiles between 2001 and 2015 (Israeli Security Agency, 2015). Israel uses different measures against Hamas and other Gazan militants. The most common one is attacking them via airstrikes, and in three occasions it also resorted to military operations that included the incursion of ground forces into Gaza.

Our study focuses on these interactions between Israel and Gazan militants. We build our main dataset using daily security reports of notable violent incidents in Gaza recorded by UN observer teams dating from October 2006 through December 2014. We begin analyzing the UN reports on June 15th, 2007, the date on which Hamas seized control of the Gaza Strip from Fatah security forces. The original reports are stored in MS Word files. We batch-convert these to OpenOffice files, then import their text content to Python and exploit formatting regularities to extract the date, timestamp, and location of every single violent incident mentioned in the reports.

Figure 1 shows the security report for November 20th, 2010. The reports typically summarize each incident in two or three sentences. For example, according to the report on Figure 1, on November 19th, 2010, Gazan militants fired mortars to Southern Israel at 12:30 and 13:50 and the Israeli Air Force (IAF) retaliated by firing 4 missiles against different targets in the Gaza

[2] See Rubin (2011) and Getmansky and Zeitzoff (2014) for a review of the development of Gaza's projectiles' threat on Israel.

Strip between 15:15 and 15:40. Gazan militants counter-retaliated by firing one mortar at 19:25, and the IAF attacked again at 23:30. We exploit contextual knowledge and verb patterns using a grammar parser to extract the attacker, target, type and quantity of munition, and casualties associated with each violent action. We cross-validate these data with daily human-coded aggregation of the same reports, finding a 99% correlation for daily projectile tallies fired from Gaza towards Israel, and a 98% correlation for daily airstrike tallies.[3]

Figure 2 presents the daily tallies of IAF's airstrikes and Gazans' projectiles using UN data. A total of 8,653 Israeli airstrikes and 16,475 projectiles fired from Gaza towards Israel are reported between June 15th, 2007 and December 31st, 2014. This shows the high frequency of violence during this period. Out of 2,740 days included in our sample, Gazan militants fired at least one projectile in 46.8% of them (1,283 days) and the IAF carried out at least one airstrike in 18.4% (504 days).

These numbers mask a great deal of variation in the level of violence over time. This pattern is clearly depicted in Figure 2. The figure shows a relatively low number of daily attacks, together with extremely violent periods occurring right before and during major confrontations between Israel and Hamas. These include the three main Israeli military operations: Operation Cast Lead (December 27th, 2008 until January 18th, 2009), Operation Pillar of Defense (November 14th, 2012 until November 21st, 2012) and Operation Protective Edge (June 12th, 2014 until August 26th, 2014). Gazan attacks are more evenly distributed over time, whereas Israeli attacks substantially increase during major operations. This figure also shows that the overall level of violence substantially decreases after those operations vis-à-vis the level of violence before the operations. Within 30 days before those operations, Gazan fired 1,035 munitions and Israel conducted 182 airstrikes. The total number of attacks decreases to 81 munitions and 42 airstrikes for the 30 days windows after those operations.

We complement the available UN data with weekly counter-terrorism reports on Gaza compiled by the Meir Amit Intelligence and Terrorism Information Center, an Israeli think tank. Meir Amit's reports on Gaza date back to April 15th 2009.[4] They are compiled by Israeli staff,

[3] During this period Gazan militants fired mortars and rockets towards Israel. Our data set contains detailed information on the type of projectile fired, and we use that information in our empirical analysis. In the text of this paper 'projectiles' refers to mortars and rockets.

[4] These reports are freely accessible at http://www.terrorism-info.org.il/. Our analysis includes all the reports between April 15th, 2009 until July 1st, 2016.

drawing on the IAF's twitter feed, other social media sources, and official websites of Palestinian militant groups. These reports are not nearly as comprehensive as those compiled by the UN ground teams. That said, they are valuable in establishing, when possible, the main motive behind each violent action, specifically whether it is retaliatory. We human-code each violent incident recorded in these reports.

Using Meir Amit data we identify 303 Israeli airstrikes and 26 Palestinian projectiles launches as reprisals explicitly linked to earlier recorded provocations. Reprisals represent 85.8% of all Israeli airstrikes and 4% of all Palestinian projectile launches recorded in the Meir Amit data. The substantial difference in terms of reprisals (85.8% versus 4%) could well be driven by reporting bias: Meir Amit is based in Israel and is partly staffed by Israeli army veterans, which may lead them to follow more feeds from Israeli sources than Palestinian. We therefore conclude nothing directly from these data. Instead, in Figures 3 and 4 we exploit the reprisal data only to calculate the typical delay in carrying out a retaliatory attack.

As Figures 3 and 4 suggest, both Israelis and Gazans tend to retaliate within one or two days of the initial attack, with few exceptions. The speediness of retaliations makes sense for at least two reasons. First, both sides have the technological capability to retaliate within hours of an attack. Israel keeps fighter-jets ready to scramble. It also has drones in the skies over Gaza which, according to our data, oftentimes spot and strike militant rocket crews even while they are setting up to launch. Similarly, as already established by Haushofer et al. (2010), the technology for launching mortars and rockets allows Gazan militants to retaliate within hours of provocation.[5] Secondly, apropos the deterrence-blowback tradeoff, each side wants the other to interpret its retaliation as a reprisal, i.e. as a price of the earlier provocation. Performing retaliations soon after a provocation helps establish this causal linkage in the minds of internal and external audiences. If for some reason the reprisal is delayed, the actor has added incentive to announce publicly that this is a reprisal for the earlier provocation, thus raising the probability that Meir Amit records it as such. We should therefore expect that the observed retaliation delays are, if anything, biased upward by this selection issue.

[5] This contrasts with suicide attacks launched from the West Bank during the Second Intifada, which potentially required weeks of planning [see Jaeger and Paserman (2008) and Brym and Araj (2006)].

3. Episodic Aggregation of Violent Attacks

We define a violent *episode* as any sequence of projectile launches or airstrikes preceded and followed by at least *t* days of calm. Table 1 describes episodes of violence, varying the intervening length of calm that defines an episode.

Let us focus first on Column (1) of Table 1, which depicts episodes' characteristics using a 'two days of calm' threshold and considers all projectiles launched by Gazan militants (5,191 mortars and 11,284 rockets). There are 312 episodes of violence between 2007 and 2014. Panel A shows that most episodes are short-lived, with over 50% lasting less than 24 hours, and over 75% lasting less than 4 days. As shown below, episodes lasting less than one day consist mostly of projectile launches from Gaza without an Israeli retaliation. There are a few episodes that continue for a long time. For example, the episode with the longest duration lasted 129.8 days. This episode started on January 23rd, 2008 and ended on June 6th of the same year. This episode showcases the sustained high levels of violence that characterized the period before Operation Cast Lead, which started the last week of 2008 and lasted for three weeks (see also Figure 2).

Panel B reports that Gazan militants initiate 91% of episodes. The remaining 9% of episodes started by an Israeli airstrike usually involve targeted killings.[6] Gazan militants also tend to end episodes, as they launch the last attack in 84.9% of episodes. This provides strong evidence that episodes are not related to each other cyclically. If they were cyclically related, we would expect that the side fired upon last in a given episode would be the first to fire in the next. Instead, Gazan militants overwhelming start and end exchanges of fire. We also observe that projectiles launched from the Gaza Strip go unanswered by Israel in 58.7% of all episodes. If we add to that the episodes with only Israeli violence, fully 60.9% of all episodes do not constitute cycles of violence in the sense that only one side commits violent attacks.

Panels C and D present summary statistics on the intensity of attacks. The message that emerges from these panels is consistent with that obtained in Figure 2. Most days are characterized by low levels of violence consisting of at most 2 projectiles launched from Gaza without an Israeli retaliation (in 75% of days in our sample the number of projectiles is less than 6). At some point, an extremely violent episode starts, including a major military operation,

[6] For example, Israeli started a violent episode on March 9th, 2012 when it used an airstrike to kill Zuhir al-Qaisi, the secretary general of the Popular Resistance Committees, a militant Gazan organization. On November 14th, 2012 the IAF started another episode by killing Ahmed al-Jabari, second in command of Hamas' military wing (see Nanes (2019) for a description of these targeted killings).

which may lead to up to 1,315 barrages of projectiles being launched from Gaza, together with up to 2,291 barrages of airstrikes by the IAF.[7]

The final panel of Table 1 reports summary statistics on periods of calm between episodes. These periods are short lived. Half of them last less than 3.4 days and 75% of them last less than 5.3 days. That said, there was a period of over two months without any projectile or airstrike being launched, between December 23rd, 2012 and February 23rd, 2013. This period of calm occurred a month after the ending of Pillar of Defense, a major military operation, and during the Israeli parliamentary elections of 2013 (voting took place on January 22nd, 2013). The duration of this period of calm was perhaps also affected by the inauguration of Barack Obama for his second term as president of the United States.

Column (2) in Table 1 presents the same summary statistics when we exclude mortars, restricting attention to Qasaam and Grad rockets only. Due to their short range and poor precision, most mortars explode in empty Israeli agricultural fields surrounding Gaza. The majority of the Israeli public is less affected by mortars, so perhaps the IAF is less prone to retaliate against mortar attacks.[8]

Eliminating mortars from the analysis brings about a slight increase in the number of episodes because we now classify days with only mortar attacks as days of calm. In addition, it shortens the duration of episodes and, obviously, the number of attacks from Gazan militants. Yet, the basic conclusions from column (1) hold. We still observe that most episodes of violence are started and ended by Gazan militants, and over 52% include only Gazan militants' violence without any Israeli attack. In addition, 87.3% of episodes start with Gazan militants' violence and almost 80% of episodes end with Gazan militants' attacks. Hence, even when we exclude mortars from the analysis we do not observe a cycle of violence between episodes.

Columns (3)-(4) and (5)-(6) redefine episodes using more stringent requirements of 7 and 14 days of calm, respectively. The main results are robust to these alternative definitions of

[7] A barrage of projectiles includes up to 5 projectiles launched at the same time. A barrage of airstrikes includes up to 3 airstrikes that occurred simultaneously. For example, the 2,291 barrages of airstrikes that occurred during operation Protective Edge in July and August of 2014 correspond to 5,551 airstrikes. The 1,315 barrages of projectiles launched from Gaza during that operation correspond to 1,326 mortars and 4,607 rockets.

[8] Note, however, that several studies show that mortar attacks are associated with localized increases on miscarriages (Wainstock et al., 2013), post-traumatic stress disorder (Diamond et al., 2010; Berger et al., 2012), and depression (Goldberg et al. 2013). Getmansky and Zeitzoff (2014) show that they also affect the electorate's political preferences.

episodes. In particular, we continue to find that (i) Gazan militants overwhelmingly start and end episodes; and (ii) in a substantial share of episodes we only observe Gazan militants' violence.

4. Full Characterization of Episodes of Violence

This section studies the effect of retaliation on future levels of violence *within* and *between* episodes. For that purpose, let us first define a *cycle of violence* within an episode. Neither a single projectile attack, nor a projectile attack answered only by an airstrike, are enough to constitute a *cycle*. For a cycle, we require at least one counter-retaliation, i.e. one projectile launch after the retaliatory airstrike. We define the length of a cycle of violence as the number of alternating attacks (the number of times the identity of the attacker alternates within the episode, plus one).

To understand these definitions, consider the following example, an episode documented by the UN, beginning on November 15th, 2010 and ending four days later (see Figure 1). The episode begins after dark at 11:15 PM, when unidentified Gazan militants fire a rocket at the Israeli border town of Sderot. Over the next four days six more rocket attacks and four mortar barrages are perpetrated, the last occurring at 1:50 PM on the afternoon of November 19th. (We classify all projectile launches from November 15th through November 19th as part of the same episode because there are not two days of calm between these attacks.) At 3:15 PM on the afternoon of November 19th, the IAF bombs a house under construction in the Deir al Balah area in response to the projectile fire (as reported by Meir Amit). Additional airstrikes follow five and twenty minutes later, at least one of them targeting a Palestinian Islamic Jihad (PIJ) training base west of Khan Younis Camp. Up until this point, we have not yet witnessed a cycle of violence. As far as we know, five days of sustained rocket and mortar attacks on southern Israel have provoked an Israeli retaliation of three airstrikes. This is consistent with a logic of deterrence. But does it provoke blowback?

Later on the evening of November 19th at 7:25 PM, militants appear to respond to the afternoon's airstrikes with a rocket launch from Nuseirat Camp. We classify that as a cycle of violence, in the sense that the Israeli retaliation in the afternoon has apparently provoked a counter-retaliation by Gazan militants. Incidentally, the rocket explodes in mid-air. Nevertheless, a few hours later at 11:30 PM, the IAF fires two missiles at smuggling tunnels near Rafah Crossing, as if to counter the counter-retaliation. Finally, Gazan militants strike back at 5:30 AM

with a mortar barrage aimed at the Israeli military base adjacent to the border town of Kissufim. This concludes the episode in our coding, as the next violent attack occurs nearly a week later on November 25th. Since we witnessed three counter-retaliations within this episode (two by Gazan militants and one by the Israelis), we code this cycle with a length of 5: the initial attack by Gazan militants, the Israeli retaliation, and three counter-retaliations.

Using this definition, we fully characterize all violent episodes into six different types, based on the strategies followed by Gazan militants and Israel. This categorization appears in Figure 5. The analysis starts on a period of calm, after at least two days without attacks. Provided that the conflict between Gazan militants and Israel is not currently in the midst of a violent episode, Gazan militants start an episode with probability 0.181 and Israel starts an episode with probability 0.018. Let us first follow episodes started by Gazan militants' violence. If Israel does not retaliate to the initial Gazan militants' attacks, and at least two days of calm go by, the violent episode ends. There are 183 violent episodes that include only Gazan violence. Israel retaliates to 35.6% of initial attacks by Gazan militants.[9] If Israel retaliates and at least two days go by without a Gazan counter-retaliation, the episode ends. This occurs in 19 episodes. If, on the contrary, Gazan militants counter-retaliate to the Israeli retaliation we observe a cycle of violence started by Gazan militants. This occurs in 82 of the 312 violent episodes. Using the same logic, we classify the 28 episodes that start with an Israeli airstrike.

Figure 5 describes the main characteristics of each type of episode. The figure shows that retaliations to an initial aggression (either by Israel or Gazan militants) are likely to lead to a cyclical episode. Gazan's counter-retaliate 81.2 percent of the times whereas Israel counter-retaliates 52.4 percent of the times. Most episodes with an Israeli retaliation last less than a week and have less than 5 alternating attacks. The median number of barrages of attacks after an Israeli retaliation is either 15 or 3, depending on whether or not Gazan militants counter-retaliate. Similarly, most episodes with a Gazan retaliation last less than 8 days and have a length below 7 attacks. The median number of barrages of attacks after a retaliation by Gazan militants is either 21 or 3, depending on whether or not Israel counter-retaliates. Although we focus on the characteristics of the median episode, note that episodes with retaliations show a great deal of

[9] An Israeli retaliation does not necessarily occur after the first attack by Gazan militants. In most cases, Israel retaliates after a number of successive attacks that occur within two days of each other. We analyze the pattern of Israeli and Gazan retaliations in more detail below.

variation in terms of their level of violence, and three of them turned into major and protracted Israeli military operations.

Israeli retaliation does not seem to lead to immediate de-escalation of violence within an episode, at least in terms of the type of projectiles launched by Gazan militants. The probability that Gazan militants launch a Grad rocket or a Qasaam rocket (which have longer range and are more precise than mortars attacks) within an episode increases after the first Israeli retaliation. In addition, whereas Gazan militants wait on average only 6 days to launch a Grad rocket and 4.1 days to launch a Qasaam rocket after an episode with an Israeli retaliation, they wait on average 34.6 days to launch a Grad rocket and 5.67 days to launch a Qasaam rocket after a non-cyclical episode.

Episodes with retaliations tend to last longer and to include more barrages of attacks than do episodes without retaliations. Importantly, retaliation does not lead to substantially longer periods of calm in the aftermath of an episode. We observe a median of 3.1 or 3.7 days of calm after an Israeli retaliation, and a median of 3.6 days of calm after episodes without an Israeli retaliation. Similarly, after episodes started with Israeli attacks, we observe less days of calm for those that include Gazan retaliations compared to those that do not. In sum, when looking at within episodes characteristics, it seems that retaliation leads to blowback and does not deter future violent attacks for longer periods of time.

Figure 5 shows that retaliation does not have an immediate deterrent effect. Arguably, the effects of retaliation may be realized over a protracted period of time. Figure 6 addresses this possibility by focusing on the characteristics of violent episodes immediately *after* each type of episode classified in Figure 5. For example, the first column describes the characteristics of the 183 violent episodes that erupted immediately after episodes that included only attacks by Gazan militants.

Episodes started by Gazan militants that have an Israeli retaliation lead to subsequent episodes that last longer and are slightly more violent (both in terms of their length and probability that Grads and Qasaam rockets are launched), compared to episodes without an Israeli retaliation. In addition, the probability that the subsequent episode includes a cycle of violence increases substantially after an Israeli retaliation. For episodes with an Israeli retaliation, the probability of a subsequent cycle is 52.64% (for episodes without a Gazan counter-retaliation) or 39.03% (for

episodes with a Gazan counter-retaliation). The probability that the subsequent episode has a cycle of violence is only 20.88% for episodes without an Israeli retaliation.[10]

Regarding episodes started with Israeli attacks, whether or not Gazan militants retaliate to the initial attack does not seem to have any effect on the duration or level of violence of subsequent episodes.

This evidence complements the findings of Figure 5. It suggests that retaliation does not immediately reduce further attacks within or between episodes, nor does it affect Israeli or Gazans strategies in future episodes.

Overall, the evidence shows that retaliation is associated with a slight escalation of violence within episodes. Israeli retaliation almost certainly leads to Gazan militants' counter-retaliation and to a cycle of violence. In addition, retaliation does not seem to deter future levels of violence across episodes. Given all of the above, why does Israel retaliate? We address this question in the next section.

5. Why does Israel Retaliate?

Whereas Israeli retaliation does not seem to deter future violence, fluctuations in past levels of attacks highly affect Israel's decision to retaliate. Figure 7 presents histograms on the number of initial Gazan projectiles attacks until the first Israeli retaliation (if at all) within an episode. The figure focuses exclusively on the 284 episodes started with Gazan militants' attacks. For these episodes, the figure's x-axis depicts the successive number of barrage of attacks by Gazan militants within an episode until the episode ends (panel A) or the first Israeli retaliation (panel B).

Figure 7 shows that Israel tends to withstand several successive barrages until it retaliates. Most episodes on the left panel have less than 3 barrages of attacks, and the mean number of barrages is 4.09 (the 75th percentile equals 5 barrages). On the contrary, the median number of barrages on the right panel is 5, the mean is 8.2 and its 75th percentile equals 11 barrages. This

[10] Note that these correlations may not be causal as some other time varying characteristic (e.g., closings of the Gaza border with Egypt due to internal political turmoil in Egypt) may be affecting the timing of Gazan attacks and Israel's policy of retaliation.

suggests that Israel follows a policy of containment hoping that the episode ends before it retaliates.[11]

Gazans' attacks in the first round within an episode are not the only determinant of Israeli retaliations. Table 2 presents a systematic analysis of Israeli retaliations using a linear probability model. The first column regresses the probability of Israeli retaliation on the number of initial successive barrage of attacks by Gazan militants within an episode (until the episode ends or the first Israeli retaliation), and whether those attacks include the launch of Qasaam rockets or Grad rockets. The results show that the severity of the initial disturbance caused by Gazans' attacks has a significant effect on Israel's decision to retaliate. The number of initial attacks and the type of munition used in those attacks affect that decision. For example, the estimated coefficients show that launching a Grad rocket (which is more precise, more lethal and has a range substantially longer than mortars and Qasaam rockets) during the initial attacks within an episode is associated with an increase of almost 37 percent on the probability that Israel retaliates.

Column (2) adds to the analysis whether or not the IAF attacked the Gaza Strip during the previous episode. We do this to control for spillover effects across episodes, which are likely to cause serial correlation. Adding this variable raises the Durbin Watson statistic to 1.940, leading us to reject the existence of autocorrelation with a significance level of 1 percent, thus solving concerns related to serial correlation of the residuals. Importantly, controlling for Israel retaliation in the previous episode does not affect the estimated coefficients of the other controls. These estimates are consistent with the analysis of Figure 6. They show that violent episodes which include an Israeli retaliation tend to lead to subsequent violent episodes that also include an Israeli retaliation. The length of previous episodes and whether or not Qasaam and Grad rockets were fired in previous episodes do not seem to have an effect on Israel's decision to retaliate.

Column 5 adds to the analysis dummy variables for all Egyptian presidents during the period at issue (the omitted category is President Hozni Mubarak who held office between 10/14/1981

[11] Note that Israel tends to employ other methods besides airstrikes to punish Gazan militants (e.g., closing of border crossings or refusal to provide electricity). Israel may also choose to delay its attacks on Gaza to better suit its internal and external political goals. For example, Durante and Zhuravskaya (2018) show that Israel tends to attack on days where the international public opinion is busy with other items to minimize international condemnation of the attacks.

and 2/11/2011). This analysis shows that the Israeli policy of retaliation is not substantially affected by Egyptian policies vis-à-vis the Gaza Strip. Israeli retaliation policy towards Gazan militants is the same under the rule of Mohamed Morsi (who belonged to the Muslim Brotherhood and repeatedly expressed solidarity with Gaza and Hamas while in power), or under the rule of Abdel Fattah el-Sisi's (who has been described by the *Economist* in May of 2016 as the "most pro-Israeli Egyptian leader ever"). Israel retaliations seem to increase only for the period under the interim rule of Mohamed Tantawi. This period was characterized by upheaval and uncertainty in Egyptian politics. The interim rule of Tantawi starts with the ousting of Mubarak after almost 30 years in power, and it doesn't include a clear policy towards Israel and the Gaza Strip. Note that the inclusion of these dummies does not affect any of the estimated slopes in the retaliation contract between Israel and Gazan's militants. They only account for a time varying intercept or control for some other time varying omitted variable.

The interaction between Gazan militants and Israel described above does not fit the behavior predicted by traditional models of deterrence (Schelling, 1966). We argue that this interaction is better understood using the theoretical framework of indirect control developed by Padró I Miquel and Yared (2012) and recently generalized by Berman et al. (2019).[12] This framework develops a dynamic principal-agent model in which the principal (Israel) uses rewards and punishments to compel the agent (Hamas) to suppress disturbances. Exerting effort to prevent disturbances is costly to the agent. The agent's effort is not observable by the principal, which introduces moral hazard into the analysis

Figure 8, taken from Berman et al. (2019), describes one of the main insights of this framework. The figure depicts the equilibrium policy of rewards and punishments that the principal chooses as a function of the amount of disturbances it suffers. There are two important features of the principal's optimal response function to disturbances. First, the principal does not retaliate to any positive level of disturbances. The principal prefers to restrain from retaliation to low and intermediate levels of disturbances because retaliating is costly and may not incentivize the agent to exert more effort to curb further violence. Second, the principal resorts to large punishments as a reaction to large levels of disturbances. These punishments are intended to

[12] Nanes (2019) provides a qualitative description of the Israel-Hamas conflict along the lines of this theoretical model.

incentivize the agent to exert high effort to curb violence now and in the future. The results of our empirical analysis corroborate these two features of the theoretical model.

The theoretical model also helps us understand why Israeli punishments through retaliations do not bring about a complete stop to rockets launches. Most of the related literature points to two main reasons behind Gazans' attacks: resisting the Israeli blockade of the Gaza Strip, and outbidding among militant groups for Palestinians' support. Israel has maintained strict control of its border with the Gaza Strip at least since it evacuated its settlements in the summer of 2005. Borders control turned into an Israeli and Egyptian blockade of the Gaza Strip after Hamas seized government institutions of the Gaza Strip from Fatah in June 2007 (Kershner, 2007).[13] The blockade has been associated with the dire performance of the Gazan economy during the last ten years. Etkes and Zimring (2015), for example, show that the Israel-Egyptian blockade of Gaza brought about a decrease in the order of 14% to 27% on its residents' welfare (as calculated using the household expenditure survey). Moreover, the Israeli-Egyptian blockade of Gaza is associated with soaring unemployment rates and increasing rates of moderate and severe food insecurity (UN report, 2016). Given all of the above, the blockade acts as a longstanding grievance that motivates Gazan militants' attacks against Israel.

The second determinant of violence often mentioned in the literature is related to the extant rivalry between Palestinian militant groups. This rivalry has historically motivated attacks against Israel as each group seeks to win new recruits, funding, and political power by proving it is more committed to resistance than its rival groups (see, e.g., Bloom (2005), Jaeger et al. (2015), and Krause (2017), among many others). Spoiler and chain-ganging tactics can therefore generate militant projectile launches even without Israeli provocation.

Thus, internal political competition among Palestinian movements, and long-term underlying grievances against Israel, are likely the main determinants of mortar and rockets attacks. Given these circumstances, to completely stop rocket launches, Israel may have to either invade and permanently occupy the Gaza Strip, or replace Hamas with another Palestinian agent that has preferences more aligned with its own. Since the first option is too costly and the second option unviable (such an agent is yet to be found), Israel is stuck in the current situation. Accordingly,

[13] Israel maintains that the blockade of the Gaza Strip is necessary to limit mortar and rocket attacks from the Gaza Strip, and to prevent Hamas from obtaining more weapons.

Israel suffers disturbances from time to time while using punishments and rewards to induce Hamas to restrain attacks.

In sum, disturbances and retaliations are an equilibrium outcome of the theoretical model based on strategies chosen by two rational actors. As a consequence, the equilibrium level of retaliations does not have a substantial effect on the equilibrium expected level of disturbances. This leads us to be cautious with our interpretation of the estimated effectiveness of retaliations. The conclusions obtained from Figures 5 and 6 rely on Israel's somewhat erratic policy of retaliations. The lack of a substantial immediate effect of retaliation on disturbances is in accordance with the equilibrium of the underlying theoretical analysis. While we are unable to estimate the effects of a policy of erratic retaliations vis-à-vis a counterfactual policy of never retaliating, the theoretical model predicts that never retaliating is associated with higher levels of disturbances.

6. Impulse Response Functions and VAR Analysis

We contrast the results of our episodic analysis with those of the VAR approach favored by the literature, replicating the analyses of Jaeger and Paserman (2008) and Haushofer et al. (2010) using the UN data. To imitate these studies, we aggregate our data to the daily number of projectiles and airstrikes attacks (or to their incidence). Our aim is to check if the conclusions we reach above showing that retaliation does not have a substantial impact on future levels of violence are not a consequence of using different data or focusing on a different time period.

We first compute nonparametric impulse response functions for levels and incidence of projectiles and airstrikes. Following Jaeger and Paserman (2008), we define the Israeli impulse response function as

$$IsrRF_t = \left(\frac{\sum_{s:G_s>0} G_s}{\sum_{s:G_s>0} 1}\right)^{-1} \left(\frac{\sum_{s:G_{s-t}>0} I_s}{\sum_{s:G_{s-t}>0} 1} - \frac{\sum_s I_s}{T}\right),$$

where I_s is the number of Israeli airstrikes on day s and G_s is the number of projectiles launched from Gaza on day s. Similarly, the Gazan impulse response function is given by

$$GazRF_t = \left(\frac{\sum_{s:I_s>0} I_s}{\sum_{s:I_s>0} 1}\right)^{-1} \left(\frac{\sum_{s:I_{s-t}>0} G_s}{\sum_{s:I_{s-t}>0} 1} - \frac{\sum_s G_s}{T}\right).$$

As pointed out by Jaeger and Paserman (2008), the empirical Israeli response function shows the excess number of Israeli airstrikes t days after a projectile attack from Gaza. Analogously, the empirical Gazan response function depicts the excess number of projectiles launched t days

after an Israeli airstrike. Following Haushofer et al. (2010) we also calculate impulse response functions for the incidences of airstrikes and projectile attacks. They have a similar interpretation, but depict the excess probability of attacks instead of excess in the number of attacks.

Figures 9 and 10 present the impulse response functions for levels of airstrikes and projectile attacks, whereas Appendix Figures A1 and A2 present the impulse response functions for incidences of airstrikes and projectiles attacks. All impulse response functions include their respective 95 percent confidence bands.

All figures show that Israelis and Gazans react in a significant and positive way to an attack by the other side. Figure 9 suggests that the IAF reacts immediately to projectile attacks. Accordingly, the excess number of airstrikes against Gaza's targets significantly increases after a projectile attack, and remains positive and statistically different from zero for roughly a month after an attack. Figure 10 depicts the analogous reaction function for Gazan militants. It shows that the initial excess number of projectile attacks after an airstrike is positive and statistically different from zero. Moreover, the increase in the excess number of projectile attacks remains statistically different from zero for almost 50 days. Figures A1 and A2 lead us to the same conclusion while looking at the excess probability of retaliations.

Next, we estimate a standard VAR model using daily indicators of projectiles and airstrikes to quantify the findings of Figures 9-10 and A1-A2. We regress daily current Israeli airstrikes and Gazan projectiles launches on lagged values of both variables. As in Jaeger and Paserman (2008) and Haushofer et al. (2010), our models also include 14 lags of both variables, which is 4 more lags than the amount recommended by various information criteria (AIC, HQ, SC, FPE). All four time-series pass the Dickey-Fuller cointegration test.

The results of these analyses are reported in Table 3. For expositional purposes, this table shows only *F*-statistics and *p*-values for the joint effect of lagged attacks (or incidents) from the rival side. For example, the *F*-statistic in the first row of column (1) (i.e., the basic model) tests whether or not all lagged airstrikes before day *t* affect the number of projectiles launched on day *t*. Similarly, the *F*-statistic in the first row of column (3) tests whether or not all lagged projectiles launched before day *t* affect the number of Israeli airstrikes on day *t*. Columns (2) and (4) perform the same analyses but focusing on the incidence of attacks instead of the number of

attacks. The bottom panel of Table 3 includes also as a control variable the number of attacks (or incidence of attacks) by the other side that occurred on day *t*.

Table 3 shows a very clear and robust pattern whereby past Israeli airstrikes provoke Gazan attacks, and past Gazan attacks provoke Israeli airstrikes. The results are robust to controlling for attacks on the same day (bottom panel of Table 3) or to focusing on the incidence of attacks instead of their levels (Columns 2 and 4). They are also consistent with the impulse response functions depicted in Figures 9-10 and A1-A2.

7. Discussion

The findings of the nonparametric impulse response functions and the VAR analysis strongly support the claim that both Israelis and Gazans retaliate to each other, suggesting a self-perpetuating cyclical conflict. The natural policy conclusion from this exercise would be that further violence could be averted if one or the other side (say, Israel) would stop shooting (back).

The evidence presented above, however, tells a different story. In particular, we find that violence occurs in short episodic bursts mostly unrelated to each other by a provocation and retaliation logic. Moreover, less than 30% of episodes escalate into cycles of counter-retaliation, and even these tend to wrap up fairly quickly. By contrast, then, the policy conclusion of an episodic analysis is that violence is unlikely to subside if Israel stops retaliating. Rather, violent attacks are driven by other, non-cyclical factors.

The different conclusions of the two methodologies highlight the advantages of an episodic analysis over a VAR or VAR-style framework. VAR correctly assesses whether Israelis, Gazans, or both sides retaliate within episodes. Yet, VAR suffers from an aggregation problem and is unable to determine that the conflict is episodic or whether these episodes relate to each other. This shortcoming is exacerbated by nonparametric impulse response functions which, unlike VAR, do not control for any autocorrelation. Consequently, VAR and nonparametric impulse response functions are unable to distinguish intra- versus inter-episodic retaliation.

Finally, VAR appears to infer causal relationships across episodes even when they do not exist. To demonstrate this, we generate a synthetic dataset where, by construction, the violence is completely episodic and diagnose long term impulse responses when we know they should be short.

In particular we generate data in Python using the following calibration of the data generating process:

Step 1: On day 1, there is a Gazan projectile attack against Israel with probability 0.135.

Step 2: If there was no attack on day 1, the episode ends, and the program advances to the next day, returning to Step 1. If there was an attack on day 1, Israel retaliates on day 2 with probability 0.342.

Step 3: If there was no retaliation on day 2, the episode ends, and the program advances to the next day, returning to Step 1. If there was retaliation on day 2, Gazan militants counter-retaliate with probability 0.663. Counter-retaliation or not, the episode ends, and the program advances to the next day, returning to Step 1.

Following these instructions, the program advances through 2,679 days, which is the length of our UN dataset minus the 61 days corresponding to major military operations. The probabilities used in the simulation correspond to the conditional probabilities of initiation, retaliation, and counter-retaliation observed in the UN data. Note that, by construction, the dataset consists of episodes where both Gaza and Israel only ever retaliate to provocations from the previous day.

We generated 100 datasets in this manner, and ran VAR on each one, allowing 7 days of lags to define an episode. Reassuringly, VAR correctly finds that Gazan projectile attacks on day *t-1* predict airstrikes on day *t*, and likewise, airstrikes on day *t-1* predict projectiles on day *t*.

In addition, though, VAR predicted in 46% of our simulated datasets that airstrikes on day *t*-2 predicted projectiles on day *t*, even though this is a spurious correlation by construction (the mean *t*-statistic for the 100 coefficients estimated for this variable equals 2.39). Likewise, airstrikes occurring more than 2 days before *t* predict projectiles in day *t* for 27% of our datasets, and projectiles occurring more than 2 days before *t* predict airstrikes in *t* for 25% of our simulations. These findings confirm that VAR struggles to distinguish between intra and inter-episodic retaliation patterns.

8. Conclusions

This paper studies whether retaliations are an effective policy of deterrence. We develop a new methodological tool based on an episodic analysis of violence which we apply to an original and thorough UN data set on Israeli – Gazan violence between 2007 and 2014. The results of our analysis show that this conflict is characterized by short-lived episodes of violence that last on

average less than 24 hours, and tend to be separated by 3.5 days of calm. We also observe that Israeli retaliations are associated with a slight escalation of violence within episodes. Israeli retaliations almost certainly lead to Gazan militants' counter-retaliations and to a cycle of violence. In addition, retaliations do not seem to deter future levels of violence across episodes.

At first glance, the retaliation policy carried out by Israel appears to have had limited success. Gazan militants continue to fire rockets at Israel, several times reaching such a high level of intensity that the Israeli military had to resorted to large-scale ground operations in Gaza. That said, we propose a subtler interpretation of our results. On top of counter-retaliating to Israeli attacks, Gazans militants use their attacks as a means of expressing grievance against the Israeli blockade of the Gaza Strip, as well as to compete with other Gazan militants for political support. Thus, there are major underlying political conditions that give rise to Gazan attacks. Absent a shift in Israeli, Palestinian, and Egyptian politics, it seems unrealistic to expect that the Israeli military, either on its own or with cooperation from Hamas, can achieve 'full' deterrence of Gazan militants. Our results show, however, that Israeli retaliations act as punishments that impose limitations to the type of munition used by Gazan militants and the intensity and targets of their attack. Hence, our analysis suggests that the Israeli military's current retaliatory policy achieves about as much deterrence as can be expected under existing political constraints.

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Figure 1: Security Report for November 20th, 2010

SECURITY UPDATE

20 November 2010
UNDSS GAZA

SECURITY PHASE: IV **SUNSET: 1650 hrs**

AREA SUMMARY (24 hours)

1. **RAFAH:**

- **19 Nov 2330 hrs an IAF F16 fighter fired 2 missiles targeting the smuggling tunnels area, opposite Yebna camp, west of Rafah, no immediate reports of injuries. Israeli sources reported that the Air Force bombed smuggling tunnels in the southern Gaza Strip Friday night and direct hits were identified, the IDF said in a statement. No injuries were reported.**

2. **KHAN YOUNIS:**

- **19 Nov 1230 hrs PRC militants fired 3 mortar shells from east of Al Qarara, east of Khan Younis, towards Eshkol Regional Council in direction of Ein Hashlosha. No reports of injuries or damage. Israeli sources indicated that Palestinians fired three mortar shells towards the southern Negev region. They landed in an open area in the Eshkol Regional Council. No reports of injuries or damage.**

- **19 Nov 1520 hrs an IAF F16 fighter fired 1 missile targeting an open area east of Bani Suhaila, east of Khan Younis. No reports of injuries or damage.**

- **19 Nov 1540 hrs an IAF F16 fighter fired 1 missile targeting an Islamic Jihad training base in the former Neveh Dekalim settlement west of Khan Younis. No injuries reported.**

3. **MIDDLE AREA:**

- **19 Nov 1515 hrs IAF F16 fighter fired 2 missiles targeting a house under construction east of Deir El Balah, 150m west of the dumping site. Severe damage reported to the house and 3 persons were wounded.**

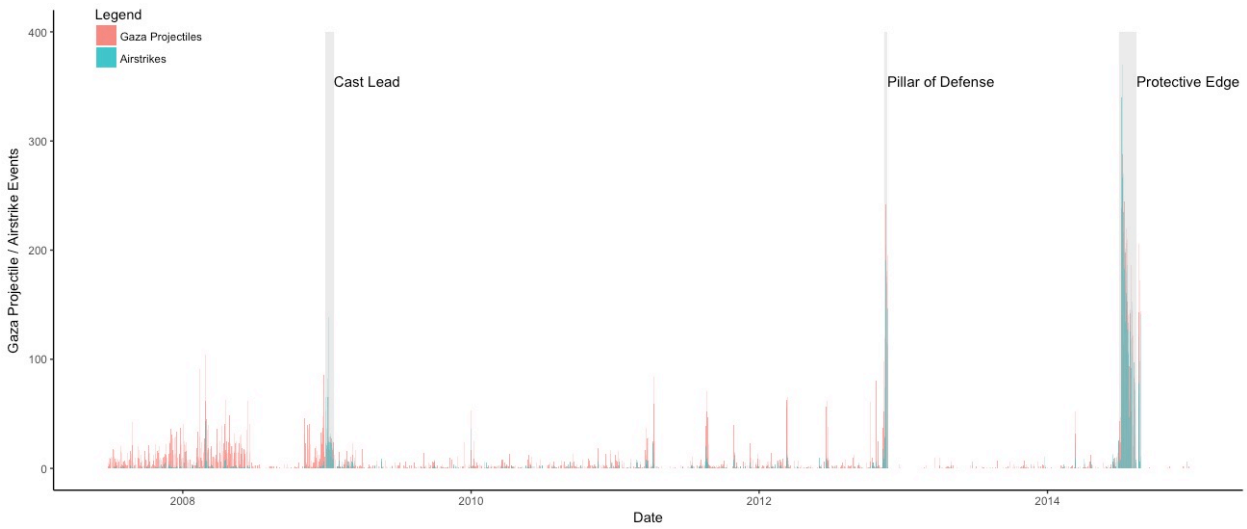
- **19 Nov 1925 hrs unidentified militants attempted to fire 1 HMR from northeast of Nuseirat camp towards the western Negev. However, the rocket exploded prematurely. No faction claimed responsibility. No injuries or damage reported.**

- **20 Nov 0530 hrs unidentified militants fired 4 mortar shells from east of Abu El Ajeen, east of Deir El Balah towards Kissufim military base. No injuries or damage reported.**

4. **NORTH AND GAZA:**

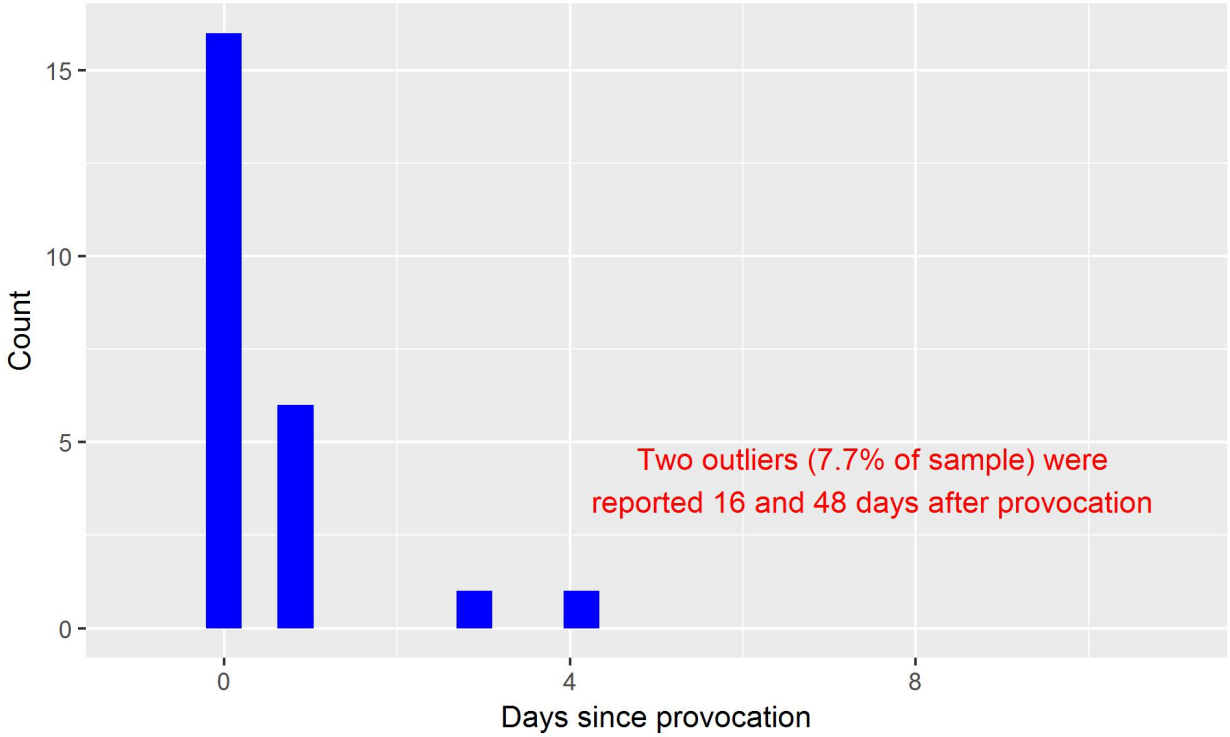
- **19 Nov 1350 hrs unidentified militants fired 5 mortar shells from north of Beit Lahia towards Ashkelon Coast Regional Council in direction of Zikim. However, 1 shell dropped-short and exploded near the security fence north of Beit Lahia. Israeli sources indicated that 4 mortar shells fired from the northern Gaza Strip landed at the Ashkelon Coast Regional Council landed in an open area. No injuries or damage were reported.**

Figure 2: Gaza Projectiles and Israeli Airstrikes Attacks, 2007-2014



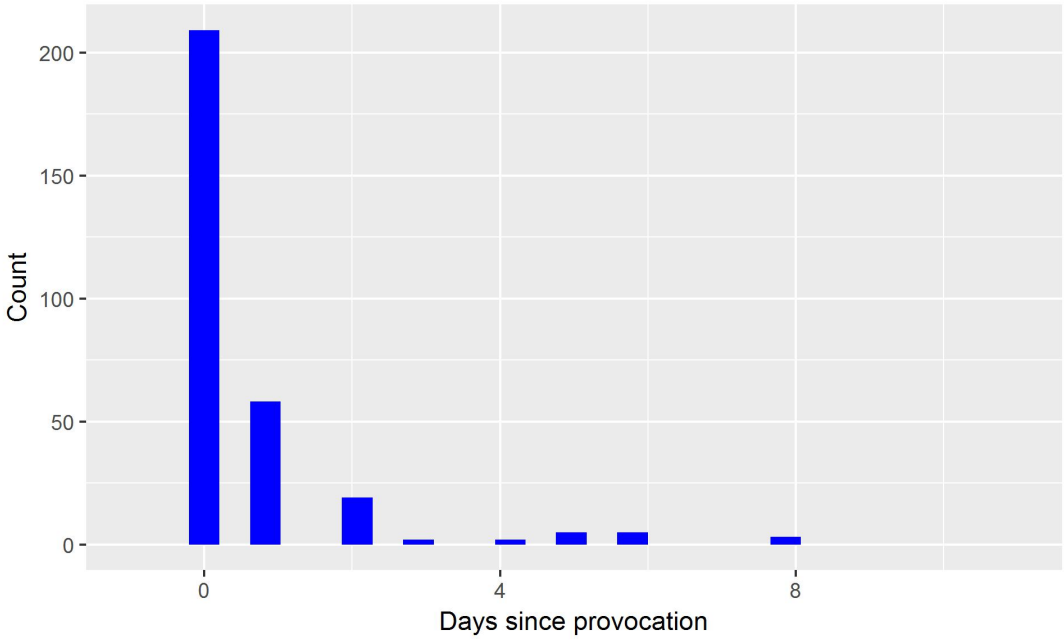
Note: Using UN data from June 15th, 2007 through December 31st, 2014.

Figure 3: Gazan Militants' Retaliatory Delays



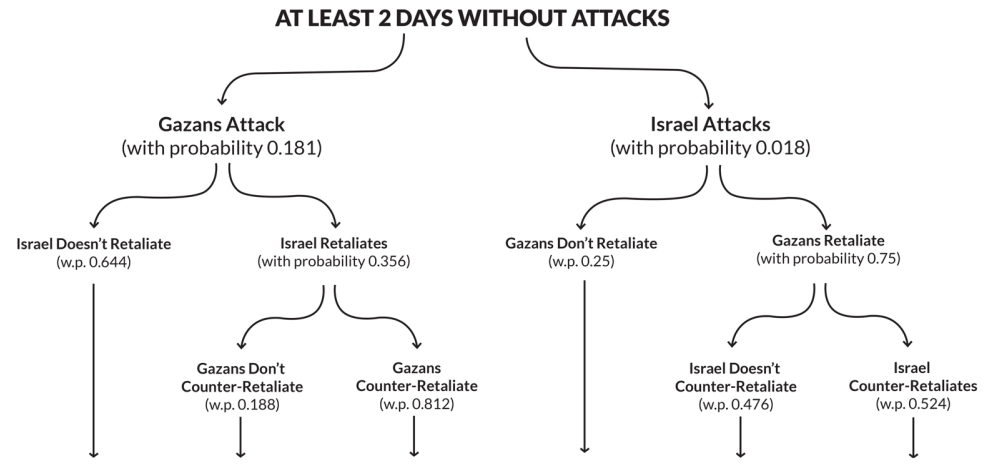
Note: Using Meir Amit data from April 15th, 2009 through July 1st, 2016.

Figure 4: Israel Air Force Retaliatory Delays



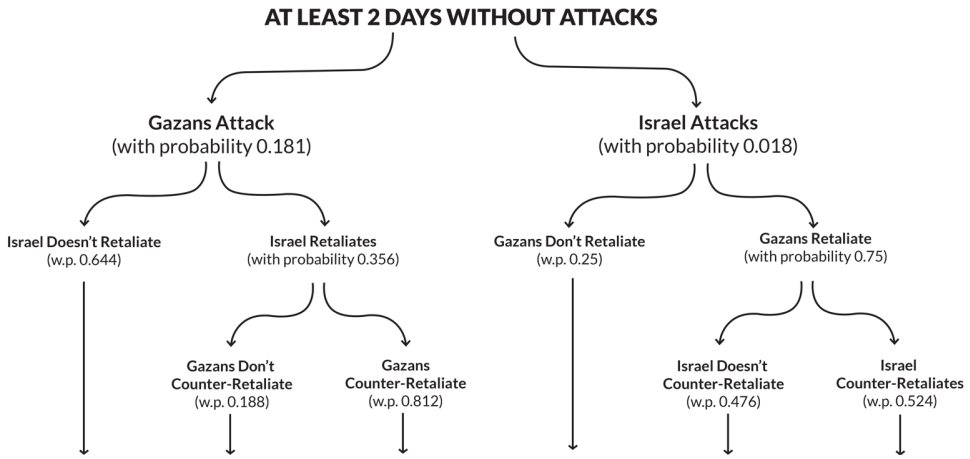
Note: Using Meir Amit data from April 15th, 2009 through July 1st, 2016.

Figure 5: Full Characterization of Violent Episodes



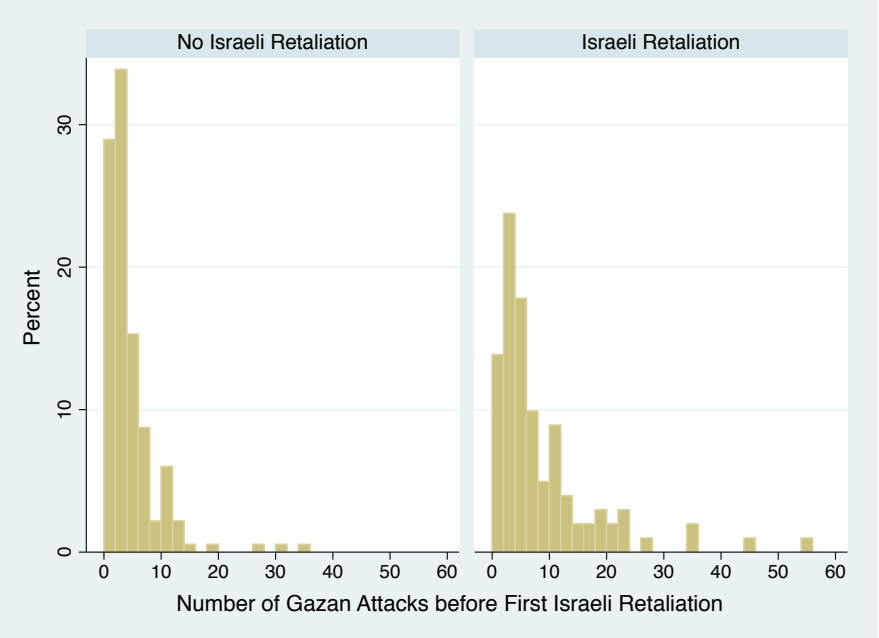
CLASSIFICATION OF EPISODE	End of Violent Episode	End of Violent Episode	Cycle of Violence	End of Violent Episode	End of Violent Episode	Cycle of Violence
NUMBER OF EPISODES	**183**	**19**	**82**	**7**	**10**	**11**
PERCENT OF TOTAL	**0.587**	**0.061**	**0.263**	**0.022**	**0.032**	**0.035**
EPISODE DURATION (in days)						
Median	**0**	**0.53**	**6.34**	**0**	**1.39**	**8.21**
Mean	**0.83**	**0.93**	**10.28**	**0**	**1.36**	**13.02**
Standard Deviation	**1.66**	**0.83**	**16.89**	**0**	**0.82**	**15.17**
EPISODES' LENGTH (alternating attacks)						
Median	**1**	**2**	**5**	**1**	**2**	**7**
Mean	**1**	**2**	**24.66**	**1**	**2**	**154.09**
Standard Deviation	**0**	**0**	**66.83**	**0**	**0**	**452.08**
NUMBER OF BARRAGES OF ATTACKS						
Median	**1**	**3**	**15**	**1**	**3**	**21**
Mean	**2.14**	**3.47**	**69.41**	**1**	**3.4**	**370.18**
Standard Deviation	**2**	**1.26**	**175.56**	**0**	**1.35**	**1074**
PERCENT OF EPISODES WITH						
Qasaam Before 1st Israel Attack	**0.809**	**0.895**	**0.915**	–	–	–
Qasaam After 1st Israel Attack	–	–	**0.976**	–	**0.7**	**1.000**
Grad Before 1st Israel Attack	**0.022**	**0.105**	**0.073**	–	–	–
Grad After 1st Israel Attack	–	–	**0.171**	–	**0.2**	**0.364**
DAYS OF CALM UNTIL NEXT EPISODE						
Median	**3.6**	**3.7**	**3.1**	**3.9**	**3.2**	**3**
Mean	**5.6**	**4.6**	**4.4**	**4.8**	**3.7**	**3.4**
Standard Deviation	**7**	**2.6**	**4**	**2.4**	**1.7**	**1.3**

Figure 6: Full Characterization of Subsequent Episodes



CLASSIFICATION OF EPISODE	End of Violent Episode	End of Violent Episode	Cycle of Violence	End of Violent Episode	End of Violent Episode	Cycle of Violence
NUMBER OF EPISODES	183	19	82	7	10	11
PERCENT OF TOTAL	0.587	0.061	0.263	0.022	0.032	0.035
SUBSEQUENT EPISODES' TYPE (percent of total)						
Gaza – –	69.23	36.84	50.00	42.86	50.00	9.09
Gaza Israel –	4.95	5.26	6.10	0.00	10.00	27.27
Gaza Israel Gaza	19.78	42.11	32.93	57.14	30.00	27.27
Israel – –	2.20	5.26	2.44	0.00	0.00	0.00
Israel Gaza –	2.75	0.00	2.44	0.00	10.00	18.18
Israel Gaza Israel	1.10	10.53	6.10	0.00	0.00	18.18
SUBSEQUENT EPISODES' DURATION (in days)						
Median	0.16	1.94	1.61	2.68	2.16	1.15
Mean	2.51	9.75	5.14	2.92	3.47	3.75
Standard Deviation	7.05	29.40	8.70	2.92	3.66	4.41
SUBSEQUENT EPISODES' LENGTH (alternating attacks)						
Median	1	3	1	3	1.50	2
Mean	6.72	13.53	27.62	2.14	2	16.55
Standard Deviation	39.96	39.54	169.07	1.07	1.33	26.44
SUBSEQUENT EPISODES' NUMBER OF BARRAGES OF ATTACKS						
Median	2	5	4	4	5	4
Mean	17.09	47.05	68.94	6.29	6.00	42.91
Standard Deviation	101.79	159.21	401.36	5.82	4.76	73.51
PROPENSITY OF SUBSEQUENT EPISODES WITH						
Qasaam Rockets	0.819	0.895	0.890	0.857	0.900	0.909
Grad Rockets	0.071	0.158	0.122	0.000	0.000	0.364

Figure 7: Number of Attacks Until First Retaliation



Note: Using UN data from June 15th, 2007 through December 31st, 2014. The figures include only the 284 episodes started with Gazan militants' violence

Figure 8: Equilibrium Policy of Rewards and Punishment Chosen by the Principal

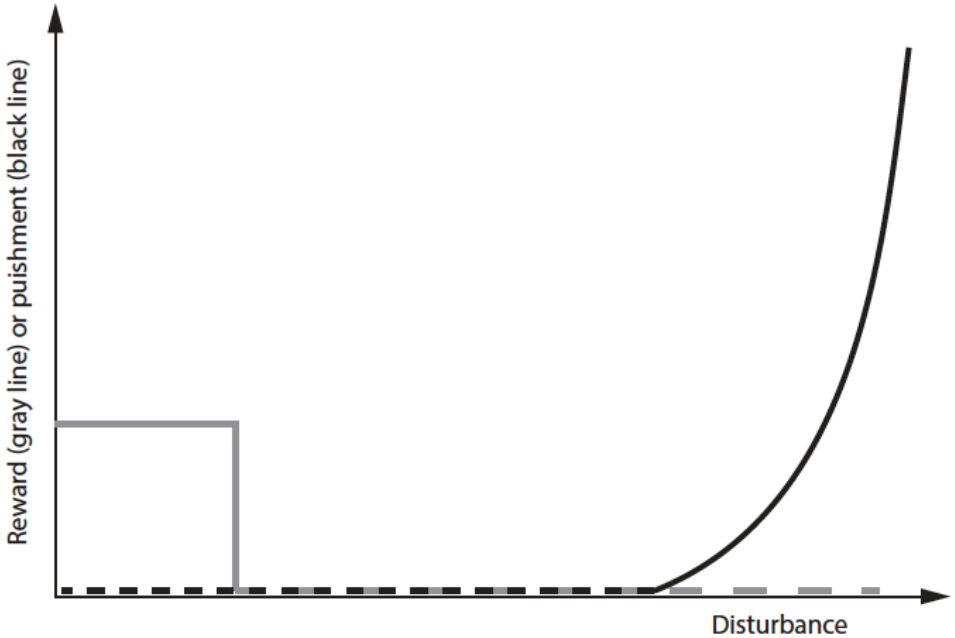


Figure 9: Israeli Impulse Response Function to Projectiles: Levels

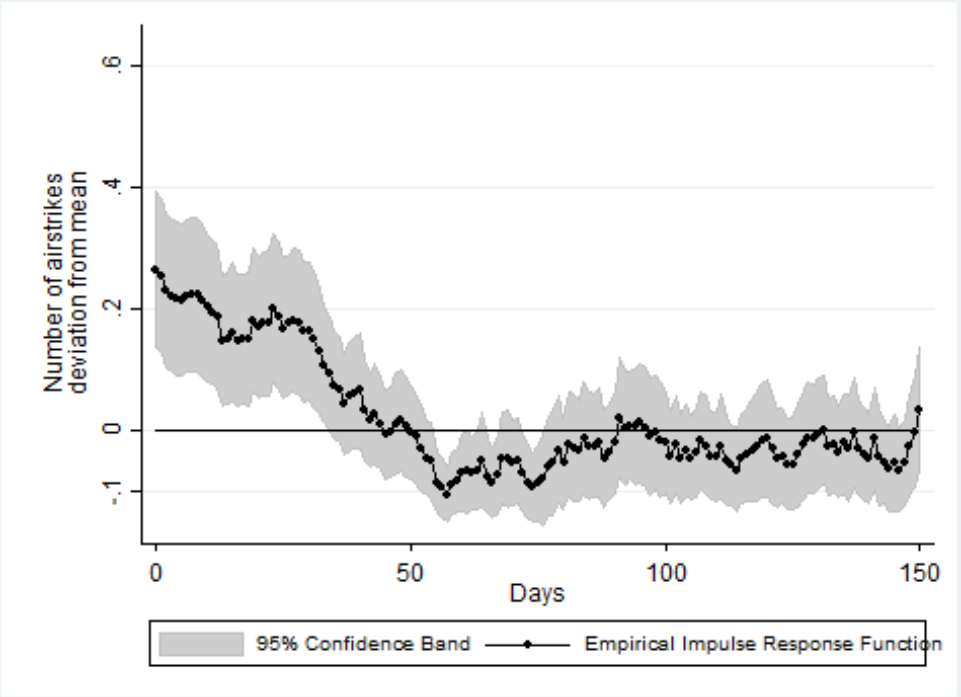


Figure 10: Gaza Impulse Response Function to Airstrikes: Levels

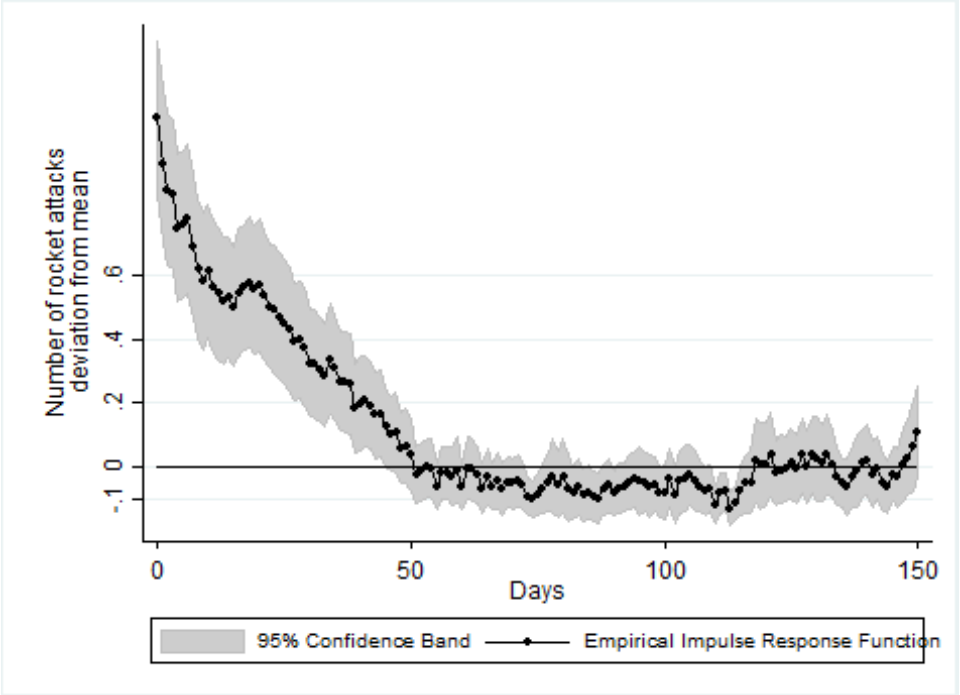


Table 1: Episodes Statistics by Number of Days without Attacks

Number of Days without Attacks between Episodes	at least 2 days		at least 7 days		at least 14 days	
	Rockets and Mortars	Rockets Only	Rockets and Mortars	Rockets Only	Rockets and Mortars	Rockets Only
	(1)	(2)	(3)	(4)	(5)	(6)
Number of Episodes	312	316	43	56	11	17
A. Episode Duration (number of days)						
Minimum	0	0	0	0	0	0
Median	0.9	0.5	11.5	7.2	55.3	55.3
Maximum	129.8	58.3	386.6	374.3	1,403.6	596.5
Standard Deviation	10.2	6.6	81.8	62.2	411.7	184.0
B. Percent of Episodes						
Started with Gazan Militants Attack	91.0	87.3	95.3	92.9	100.0	94.1
Ended with Gazan Militants Attack	84.9	79.4	81.4	80.4	81.8	88.2
With only Gazan Militants' Violence	58.7	52.2	44.2	46.4	36.4	41.2
With only Israeli Violence	2.2	4.1	0.0	0.0	0.0	0.0
C. Gazan Militants Violence (number of barrage of attacks)						
Minimum	0	0	1	1	1	1
Median	2	2	5	4	24	20
Maximum	1,315	1,082	1,646	1,334	2,564	1,335
Standard Deviation	91.0	69.5	325.1	221.3	881.5	406.9
D. Israeli Violence (number of barrage of attacks)						
Minimum	0	0	0	0	0	0
Median	0	0	1	1	5	5
Maximum	2,291	2,291	2,809	2,809	2,838	2,809
Standard Deviation	137.3	136.2	438.6	385.8	871.4	687.5
E. Number of Days Without Attacks Between Episodes						
Minimum	2.0	2.0	7.2	7.0	15.2	14.1
Median	3.4	3.7	10.4	11.0	25.9	22.8
Maximum	62.2	62.2	62.2	62.2	62.2	62.2
Standard Deviation	5.8	6.1	11.4	10.4	13.9	12.9

Notes: Calculations in the table use the universe of projectiles launches and airstrikes attacks. UN Data from June 15, 2007 until December 31, 2014.

Table 2: Determinants of Israeli Retaliation

VARIABLES	(1)	(2)	(3)	(4)	(5)
Number of Gazan Attacks in Initial Round	0.0183***	0.0155***	0.0154***	0.0155***	0.0157***
	(0.00381)	(0.00393)	(0.00405)	(0.00402)	(0.00410)
Qasaam Fired in Initial Round of Attacks	0.158**	0.151**	0.151**	0.147**	0.171***
	(0.0650)	(0.0621)	(0.0622)	(0.0630)	(0.0605)
Grad Fired in Initial Round of Attacks	0.368***	0.347***	0.347***	0.345***	0.339***
	(0.133)	(0.124)	(0.125)	(0.127)	(0.120)
Israeli Attack in Previous Episode		0.171***	0.170***	0.166***	0.128**
		(0.0585)	(0.0590)	(0.0630)	(0.0621)
Length of Previous Episode			3.84e-05	3.42e-05	3.32e-05
			(0.000144)	(0.000142)	(0.000166)
Qasaam Fired in Previous Episode				0.0437	0.0540
				(0.0714)	(0.0716)
Grad Fired in Previous Episode				-0.00973	-0.0506
				(0.116)	(0.122)
Mohamed Tantawi (2/11/2011 - 6/30/2012)					0.198**
					(0.0848)
Mohamed Morsi (6/30/2012 - 7/3/2013)					-0.0751
					(0.0956)
Adly Mansour (7/4/2013 - 6/8/2014)					-0.0775
					(0.0694)
Abdel Fattah el-Sisi (6/8/2014 - present)					0.0550
					(0.177)
Constant	0.105*	0.0590	0.0595	0.0270	0.00461
	(0.0575)	(0.0541)	(0.0544)	(0.0682)	(0.0680)
Durbin Watson Statistic	1.585	1.940	1.941	1.935	1.926
Observations	284	283	283	283	283
R-squared	0.113	0.137	0.137	0.139	0.172

Note: Linear Probability Model on the determinants of Israeli Retaliation. Robust standard errors in parentheses. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.

Table 3: Gaza Projectile and Airstrike Retaliations

		Gaza Projectiles Retaliating to Airstrikes		Airstrikes retaliating to Gaza Projectiles	
		Number	**Incidence**	**Number**	**Incidence**
Specification	**Test Statistic**	**(1)**	**(2)**	**(3)**	**(4)**
Basic	F statistic	34.856***	5.064***	5.8957***	6.2346***
	p-value	<2.2E-16	8.28E-07	7.23E-09	1.70E-09
Control Same-Day Events	F statistic	253.5***	22.537***	206.18***	22.144***
	p-value	< 2.2E-16	< 2.2E-16	<2.2E-16	<2.2E-16

Note: F- statistic and respective p-value test for the joint significance of the lagged coefficients of the respective other variable.

Appendix Figures and Tables:

Figure A1: Israeli Impulse Response Function to Projectiles: Incidence

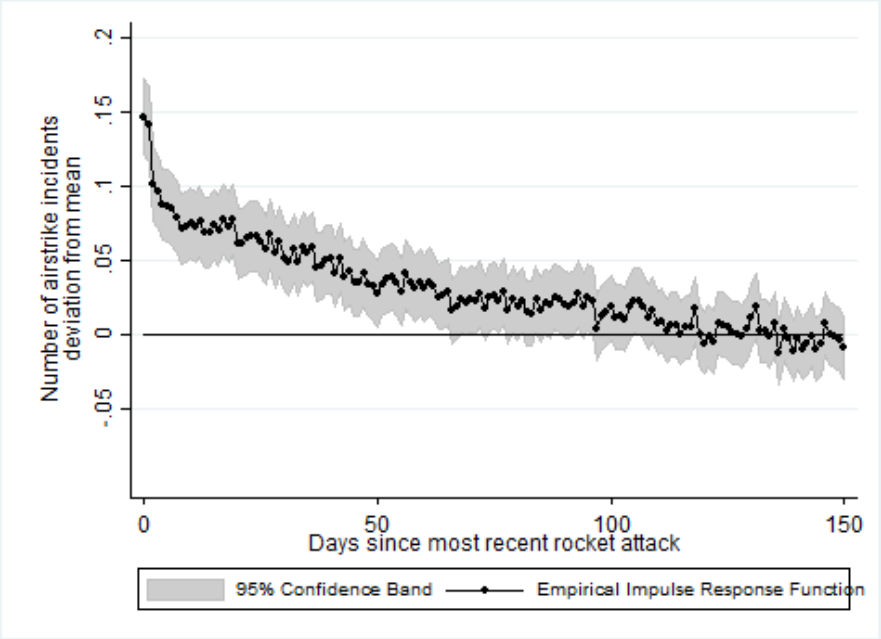


Figure A2: Gaza Impulse Response Function to Airstrikes: Incidence