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Using Social Media to Measure Conflict Dynamics: An Application to the 2008–2009 Gaza Conflict

Thomas Zeitzoff[1]

Abstract

The lack of temporal disaggregation in conflict data has so far presented a strong obstacle to analyzing the short-term dynamics of military conflict. Using a novel data set of hourly dyadic conflict intensity scores drawn from Twitter and other social media sources during the Gaza Conflict (2008–2009), the author attempts to fill a gap in existing studies. The author employs a vector autoregression (VAR) to measure changes in Israel's and Hamas's military response dynamics immediately following two important junctures in the conflict: the introduction of Israeli ground troops and the UN Security Council vote. The author finds that both Hamas's and Israel's response to provocations by the other side increase (both by about twofold) immediately after the ground invasion, but following the UN Security Council vote, Israel's response is cut in half, while Hamas's slightly increases. In addition, the author provides a template for researchers to harness social media to capture the micro-dynamics of conflict.

Keywords

conflict dynamics, Israel–Palestine conflict, social media, vector autoregression

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> What happened in the Dahiya quarter of Beirut in 2006 will happen in every village from which Israel is fired on. . . . We will apply disproportionate force on it (village) and cause great damage and destruction there. . . . From our standpoint, these are not civilian villages, they are military bases.—Gadi Eisenkot, head of the IDF's Northern Division, articulating the "Dahiya Doctrine."[1]
>
> We were fighting a modern 21st-century army, and we're just a guerrilla resistance movement . . . what did you expect—for us to stand in a field and wait for the Israelis to mow us down?—Gaza commander in the Izzedin al-Qassam brigades on Hamas's tactics during the conflict.—McGirk and Klein (2009).

Most quantitative studies of conflict use data that are aggregated annually,[2] or occasionally monthly (Brandt, Colaresi, and Freeman 2008; Goldstein and Freeman 1990), or daily (Jaeger and Paserman 2006; Kavanagh 2009). While aggregate data are useful for unpacking long-term dynamics, it may not elucidate short-term dynamics that are increasingly becoming important in military confrontations.[3] These short-term dynamics—such as decisions to escalate a conflict and tactical use of force—represent an understudied class of phenomena. I attempt to fill this gap in the literature by exploiting a novel hourly data set of conflict intensity drawn from Twitter (*AJGaza* 2009; *QassamCount* 2009) and other social media sources (*The Muqata* 2009; *Wikipedia* 2009). The editorial intervention in the social media sources and the ability to cross-reference events with mainstream media sources make this type of social media particularly suitable (as well as unique) for constructing a conflict data set.[4] I examine the change in Israel's and Hamas's tactical responses immediately following two critical junctures of the recent Gaza Conflict (2008–2009): the introduction of ground troops by Israel (Israeli Ground Invasion) and the UN Security Council vote that called for a halt to hostilities. I find that Hamas's and Israel's response intensity double immediately after the introduction of ground troops and that immediately following the UN Security Council vote, Israel cuts its response intensity in half, while Hamas's slightly increases. These findings highlight the strategic behavior of conflict participants to the heightened risk of military casualties and to international pressure to deescalate.

The low-intensity (and at times high-intensity) clashes between Israel and Hamas in Gaza (2007–current) have served as a focal point for tensions in the Middle East, with both domestic (to Israel and the Palestinians) and international implications.[5] The unique nature of the conflict means that conclusions from analyzing Hamas and Israeli actions are applicable to scholars of both domestic and international conflict. Finally, recent forays by the US military into Afghanistan and Iraq highlight the need for an improved understanding of asymmetric war—encounters between strong and weak actors—and the Gaza Conflict represents an important case to explore its political and tactical dimensions.

This article relates closely to work of Jaeger and Paserman (2006); Brandt, Colaresi, and Freeman (2008); Kavanagh (2009); and Haushofer, Biletzki, and Kanwisher (2010) in investigating reciprocity in the Israel—Palestine Conflict. Like previous studies, I

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also find support for an asymmetric response dynamic, with Israel reacting more to Hamas than vice versa—albeit over a much shorter time horizon.[6] This article also draws upon previous work on repression and dissent (Gartner and Regan 1996; Lichbach 1987; Moore 1998) in empirically investigating which tactics—coercive or accommodating—governments use to deal with opposition groups and how the opposition group (Hamas) responds (albeit at a finer level than previous studies).[7] I use a vector autoregression (VAR), pioneered in International Relations (IR) by Goldstein and Freeman (1990) and formalized by Brandt and Williams (2007), to unpack the strategic dynamics at work in the Gaza Conflict. Finally, my findings are connected to a larger literature on strategic factors in asymmetric conflict including the use of tactics (Arreguín-Toft 2001, 2006; Galula 2006; Kalyvas 2006; Lyall and Wilson III 2009; US Army and Marine Corps 2007), proportionality of military response (Gross 2008, 2009), dynamics between factional groups and incumbent forces (Bueno de Mesquita and Dickson 2007; Lyall 2009), and the role of international institutions in constraining the behavior of states (Axelrod and Keohane 1985; Martin and Simmons 1998)

The article is structured in the following manner. In The 2008–2009 Gaza Conflict section, I give a brief outline of the Gaza Conflict (2008–2009) and present Israel's and Hamas's strategies and constraints. Sections on Data and Method outline my method of data collection and empirical framework. Section on Results and Interpretation reports the results of the statistical analysis and a brief case study of the shelling near the UNRWA[8] school (Al-Fakhura) that highlights the role of the civilian population in the conflict. Section on Future Research offers some suggestions for future research. For further explanation of the conflict intensity scores and statistics presented refer, to the Appendix.

The 2008–2009 Gaza Conflict

On December 27, 2008, at approximately 11:30 a.m. (Israeli time), the Israeli Air Force (IAF) began a massive bombardment of Hamas targets throughout the Gaza Strip.[9] The IAF bomardment was reportedly in response to the barrage of Qassam and Grad rockets[10] fired into Israel since Hamas ended its self-imposed cease-fire on December 19, 2008.[11] The continued Hamas rocket attacks would serve as the pretext for the eventual Israeli ground invasion.

On January 4, 2009, Israeli Defense Force (IDF) ground forces, including tanks and large-scale infantry, entered Gaza and remained until January 21, 2009. The stated goal of the IDF in Gaza (named Operation Cast Lead) was to halt the increased rocket fire after Hamas chose not to renew the cease-fire. The IAF used large-scale aerial bombing against infrastructure targets, police stations, and smuggling tunnels in Gaza, along with targeted strikes against Hamas leaders.[12] IDF ground forces maneuvered behind tanks and under the cover of artillery fire in their limited incursion into Gaza. The Israeli military chose to remain on the outskirts of Gaza City instead of facing potentially entrenched Hamas fighters (McGirk and Klein 2009). Occasional heavy skirmishes and fierce battles occurred (particularly around Gaza

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City), yet the ground conflict mirrored the asymmetry in air power, with Hamas refusing or unable to confront Israel's heavy, mechanized infantry. Israel's superiority of force was also reflected in the lopsided casualty numbers. By the cessation of hostilities, approximately 1,300 Palestinian deaths compared to just 13 Israelis killed were attributed to the monthlong fighting (*The Economist* 2009).

The decision to exploit their military advantage and conduct a limited ground offensive had its roots in the 2006 Israel-Hezbollah War (widely considered as a failure; *The Economist* 2009). The failures in 2006 shaped the IDF's plan to weaken Hamas's ability to launch rockets into Israel—first with air strikes and then through a limited ground campaign—while it still enjoyed tactical superiority.[13] Israeli military planners were cognizant of the danger of becoming entangled in a guerilla campaign in the Gaza Strip, with entrenched Hamas fighters in densely populated urban environments. Rather, they sought to use their overwhelming force and technological advantages to stymie Hamas's rocket attacks. Finally, the Israeli elections were a month away and the ruling Kadima party, expected to face a stiff test from the more right-wing Likud party, and was loath to be perceived as "weak" in the face of Hamas antagonism (Associated Press 2009).

Hamas's decision to not renew the cease-fire and escalate its rocket campaign against Israel was partly rooted in solidifying its control over Gaza vis-á-vis Fatah. After Hamas won legislative elections in 2006, a series of violent clashes occured between Hamas and Fatah for control of the Palestinian Authority in the West Bank and Gaza.[14] In the 2007 Battle of Gaza, Hamas wrested control of Gaza from Fatah. In retaliation, Fatah forcibly expelled Hamas from the West Bank (Erlanger 2007). Sporadic clashes and arrests of Hamas members in the West Bank and Fatah members in Gaza continued up through December 2008, as both sides jockeyed to solidify their position among the Palestinian population (*The Economist* 2009).[15] Hamas, and hence Gaza, was isolated internationally as it refused to recognize Israel as a state, renounce violence, and follow previous Palestinian Authority agreements reached with Israel.[16]

The Israeli ground invasion marked an important turning point in the Gaza Conflict. Prior to the Israeli ground invasion, the IAF had hammered Hamas targets through a mixture of air strikes, large-scale bombing, artillery strikes and other blunt (as compared to ground troops) tools of war. Traditional counterinsurgency (COIN) doctrine states that having "boots on the ground" facilitates information gathering and the use of selective force—a key to success in population-centric warfare (Galula 2006; US Army and Marine Corps 2007). The IDF moved cautiously on the ground in Gaza, refusing to stay put and be "sitting ducks" for Hamas snipers and ambushes (McGirk and Klein 2009).[17]

Hamas employed guerilla tactics to attempt to stymie the military superiority of the IDF.[18] Before the Israeli ground invasion, Hamas used rocket and mortar attacks to harass and intimidate Israeli towns and cities within range. In preparation for the Israeli assault, Hamas hid weapons and bomb-making materials near mosques, schools, and other civilian areas (Erlanger 2009). They also constructed road-side

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bombs, tunnels, and booby traps in order to avoid directly confronting the stronger IDF (McGirk and Klein 2009). In one instance, Hamas rigged up a mannequin inside a building with explosives, hoping that confused IDF soldiers, during the haze of securing the building and watching for ambushes, would fire at the mannequin causing the building to implode on the soldiers (Erlanger 2009). While the mannequin ambush was unsuccessful, it underscores the irregular tactics Hamas used.

The UN Security Council voted on a resolution on January 8, 2009, the thirteenth day of the conflict, that called for an immediate cease-fire. Fourteen out of the fifteen members favored the resolution, with the United States abstaining (AJGaza, 2009). The vote placed strong international pressure for both sides, but particularly Israel, to end the conflict and for Israel remove its military forces from Gaza. It may have also placed a constraint on Israeli tactics by increasing the cost of continued Palestinian civilian casualties. Israel would be less inclined to plan operations with a high probability of civilian casualties after the UN Security Council resolution. Moreover, there are reports that after the UN Security Council vote, US President-elect Obama placed increasing pressure on Israel to end hostilities before his January 20, 2009, inauguration.[19]

Hamas faced a different trade-off than did Israel to international pressure. A constrained Israel presented Hamas with the opportunity to attack Israel with a lower probability of a strong reprisal. Hamas, already isolated internationally, and as the much weaker military force, was less constrained by the UN and international opinion. The IDF utilized official blogs, press spokespeople, and other media to disseminate information and support Israeli military actions in Gaza. The concerted Israeli media effort highlights the importance Israel placed on not being seen as wantonly attacking civilians (Israeli Defense Forces 2009b). In contrast, as my analysis of the UNRWA school will illustrate, Hamas's actions were not as highly scrutinized giving them more tactical latitude (El-Khodary and Kershner 2009).

In the proceeding sections, I employ a VAR to statistically measure the effects of the Israeli ground invasion and the UN Security Council vote on the Hamas and Israeli conflict dynamics. Using the novel social media data I collected, I am able to measure how much Hamas and Israel react to each other (forecast error decomposition), the change in response dynamics (impulse response function, IRF, graphs) before and after the Israeli ground invasion and before and after the UN Security Council vote, and measure how "boots on the ground" and the constraint of international institutions change the proportionality of responses (cumulative IRF).

Data

Sources

The Gaza Conflict saw the emergence of social networking and new media sources that vastly increased the speed and dissemination of information from the battlefield.[20] Data gleaned from social media sources also present researchers with unique challenges. How do researchers verify the efficacy of information, a job traditionally done by editors? If two sources have conflicting reports on an event, how does one

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determine which is more trustworthy? All of these challenges must be answered in order to harness social media as a new source of data on conflict.

Many researchers have grappled with how to systematically categorize contentious events[21] from multiple, conflicting resources. Davenport (2009) investigates media bias in the reporting of the Black Panther Party (BPP) and US government interactions. He describes a "Rashomon Effect,"[22] whereby reports about the US government—BPP interactions are influenced by the political orientation of the reporting source. He further argues that researchers should be cognizant of variation in the media reports (possibly using this variation to better understand the conflict) and draws upon multiple sources when constructing data sets from conflicting sources. Almeida and Lichbach (2003) investigate differences in coverage of the Seattle 1999 World Trade Organization (WTO) protests between national media, local news, and activist websites. They find substantial differences of the quantity and threshold intensity of events reported—with activist websites reporting protests regardless of their size, whereas national media reports only the larger ones. They argue that both activist and conventional media should be utilized to more accurately report global movements.

For my data collection, I relied principally on three sources. Due to Hamas isolation and the danger of reporting from Gaza, many traditional news media outlets removed their reporters. Al-Jazeera was one of the few news agencies that had reporters on the ground in Gaza. To facilitate information collection, it set up a "crowdsourcing" reporting platform through Ushahidi[23] called *War on Gaza: Experimental Beta*.[24] This allowed citizens and reporters to send SMS and Twitter messages through their cellular phones or computer to a database where Al-Jazeera would then authenticate the stories (AJGaza, 2009). Events were then put into a Twitter feed titled *AJGaza*, which gave the event a time stamp (AJGaza, 2009). By cross-checking with other sources such as Reuters, the UN, and the Israeli newspaper *Haaretz*, I was able see that the time stamp was usually within a few minutes of event occurrence. *AJGaza* provided excellent coverage of the Israeli air strikes and ground offensive; including geographic and temporal information on where skirmishes were occurring. However, since the platform was set up to report on conditions on the ground in Gaza, it had a tendency to underreport Hamas rocket fire into Israel.

In order to capture the Hamas rocket fire, I examined two sources: the *QassamCount* Twitter feed and the *The Muqata* blog (*QassamCount* 2009; *The Muqata* 2009). The *QassamCount* reported where Hamas rockets landed, when they landed, and what type of rocket was used (Qassam or longer-range Grad rocket). Each rocket incident was accompanied by a link to a *Haaretz* or *Ynet.com*[25] article that allowed me to verify its accuracy. *The Muqata* is a pro-Israel blog that live-blogged as events unfolded in the conflict. It provided links to news stories, information on confrontations between the IDF and Hamas, and details on Hamas rocket attacks at an even finer level than the *QassamCount*. The blog also received input from contributors, as its chief concern was tracking Hamas aggression against Israel. Occasionally, the

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time between a rocket attacked posted on *QassamCount* and *The Muqata* would differ, with the latter usually being faster at reporting events than the former. I therefore used *The Muqata* as my time stamp for when the event occurred.

Wikipedia's "Timeline of the 2008–2009 Gaza Conflict" was particularly helpful in sourcing and targeting controversial events that might have divergent reports (*Wikipedia* 2009). For example, the Israeli shelling (on or near) the UNRWA school that occurred on January 6, the eleventh day of the conflict, was viewed around the world with outrage. Israeli media sources stated that Hamas militants had been firing from the school, whereas Palestinian and UNRWA officials claimed otherwise and that the school received a direct hit (*AJGaza* 2009; *The Muqata* 2009). It was important to determine (to the best of my ability) whether or not militants were operating in the school and whether or not Israel had actually hit the school, as it would influence how I would eventually code Isreali and Hamas actions. *Wikipedia* provided links to reports that supported both sides' versions of the event. I determined that it was more likely that Hamas had been near but did not use the school as a place to fire on Israel troops. It also was clear that Israel did not directly hit the school. The UN later clarified its initial statements saying that rockets had struck near the school but had not hit the school itself (McGirk 2009). The IDF also backed away from its claim that Hamas was operating in the school but rather were firing from "80 meters from the school" (Israeli Defense Forces 2009a).

One must be leery with relying entirely on sources—particularly social media—that are subject to the bias of the reporter. However, global interest in the Israel-Palestine conflict, and hence the Gaza Conflict, insured that the mainstream media were also involved in the reporting. I used *The New York Times* (*The New York Times* 2009), BBC,[26] and *Haaretz* to make sure that reports from *AJGaza*, *The Muqata*, and *QassamCount* did not systematically differ from mainstream reporting. For most large events (battles, air strikes, and artillery fire), the aggregated social media sources mirrored the mainstream reporting.[27] It was in the details (i.e., individual rocket attacks, statements by ministers, low-level skirmishes, and psychological operations), where these new sources fleshed out the micro-interactions of the conflict. This level of detail is particularly important when analyzing interactions in asymmetric conflict, as weaker actors such as Hamas may choose to respond to Israeli escalation in nontraditional manners—precisely the kind of response that mainstream media does not report with as much frequency or accuracy.

Coding Methods

To measure Israeli and Hamas hostility toward each other over the 598 hours of the Gaza Conflict (from the first IAF air strikes to the last IDF troop leaving Gaza), I used a 21-point variant of the Conflict and Mediation Event Observations (CAMEO) coding scheme (Schrodt 2009). The ordinal scale goes from 0 (*no action taken*) to 20 (*massive aerial bombardment*), with everything from heightened posture (7) to misinformation/psychological warfare (11) in between (see Appendix for full list

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Table 1. Summary Statistics for Hamas and Israel Action Intensity

Group	Mean	Std. Dev.	Min.	Max.
Hamas	9.11	13.27	0	68
Israel	11.13	17.63	0	80

of codings). The coding scheme states that events that are given higher values on the scale represent a greater escalation of hostilities relative to those given lower values. From a tactical perspective, it would be false to infer that a one unit change from mortar fire to endangering civilians (12–13 on the scale) represents the same intensity escalation as a shift from artillery fire to large-scale ground forces (18–19). Rather, the coding scheme is a useful way of quantifying hard-to-quantify actions.

I used the reports of Hamas and Israeli actions from *AJGaza*, *The Muqata*, *QassamCount*, and *Haaretz* cross-referenced with mainstream media sources to determine the level of conflict intensity. Reports took the form of an actor (Israel or Hamas or both sides) and the action taken (*Demand*, *Lob mortars*, and *Wide-Spread Air Strikes*). If events happened concurrently, such as the following report, "IDF tanks and ground troops engage Hamas in fierce clashes," both sides would receive a score for that time period.[28] These events were then coded at the 15-minute interval.[29] If two events were reported in the same 15-minute interval for an actor, I took the higher event score.[30] The 15-minute intervals made the most sense, as occasionally there was an initial report of an event, shortly followed (usually within 2–5 minutes) by a follow-up report that further clarified the initial report. In an ideal world, every 15-minute period would have some "event" reported. However, even the detailed reporting of *AJGaza* and *The Muqata* did not have an incident for every interval; therefore I aggregated the 15-minute interval data to the hour level.[31]

For example, two reports (15 minutes apart) of intense rocket fire followed by a Hamas ambush and no event reported would be scored[32] for Hamas:

$$14 + 14 + 17 + 0 = 45.$$

Additionally, two 15-minute periods for which no Israeli actions occur followed by two targeted Israeli air strikes would be scored for Israel:

$$0 + 0 + 16 + 16 = 32.$$

Summary statistics of the whole conflict—from the first Israeli air strikes to the last Israeli soldier leaving—are coded in the above manner and are presented in Table 1.

Figure 1 graphs Hamas's and Israel's hourly conflict intensity scores as a time series with key events annotated.

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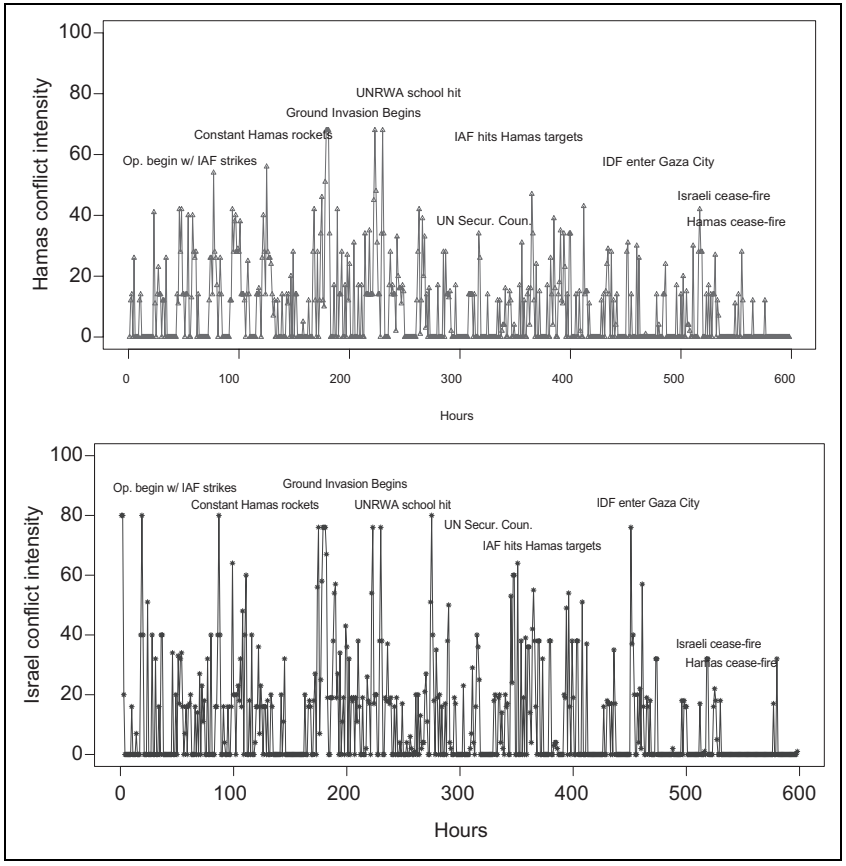

Figure 1. Time-series graph of the Gaza conflict by the hour (key events are annotated)

Method

The VAR Model: Motivation and Derivation

In examining the time-series graph and taking into account my theory of Hamas's and Israel's actions during the Gaza Conflict, an appropriate empirical strategy needs to account for the endogenous nature of each actor's decision to escalate or de-escalate. Thus, Hamas's action in the current period depends on its own past actions and the past actions of Israel. The same is true for Israel. A VAR is one way to model this interaction. The VAR approach builds on the work of the structural equation models (SEQ) while relaxing several of its strong assumptions (Sims 1980). As both Hamas's and Israel's responses depend on each other's actions, the strict assumption about inclusion or exclusion of lagged variables

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in the SEQ method may lead to an omission of important lagged variables and omitted variable bias (Brandt and Williams 2007). By testing for different lag lengths and rejecting strong assumptions not theoretically motivated, the VAR technique takes a more experimental approach to model specification. The central trade-off in VAR modeling is between reducing bias (including more lagged variables) versus efficiency (less lagged variables). Below I derive the VAR model specification using Floyd (2005) and Enders (2004) as references (Enders 2004; Floyd 2005).

Consider the following model of Hamas and Israeli interactions during the Gaza Conflict, where Hamas (y_1) and Israel (y_2) depend on the present value and one lagged value of both its action and that of the other side.

$$y_{1(t)} = b_{10} - b_{12}y_{2(t)} + \gamma_{11}y_{1(t-1)} + \gamma_{12}y_{2(t-1)} + \varepsilon_{1(t)}. \quad (1)$$

$$y_{2(t)} = b_{20} - b_{21}y_{1(t)} + \gamma_{21}y_{1(t-1)} + \gamma_{22}y_{2(t-1)} + \varepsilon_{2(t)}. \quad (2)$$

Equations (1) and (2) assume that both y_1 and y_2 are stationary and that $\varepsilon_{1(t)}$ and $\varepsilon_{2(t)}$ are white noise residuals uncorrelated with each other (Enders 2004, 264).

The above systems of equations is expressed below as a function of n endogenous variables and p lags:

$$Y_t = A_0 + A_1Y_{t-1} + A_2Y_{t-2} + \cdots + A_pY_{t-p} + E_t, \quad (3)$$

where Y_t = an $n \times 1$ vector of the endogenous variables in VAR, A_0 = an $n \times 1$ vector of intercepts, A_i = an $n \times n$ matrix of coefficients, and E_t = an $n \times 1$ vector of error terms.

Equation (3) is identified and can be estimated using ordinary least squares (OLS). Two things should be noted. First, including an extra lag in the equation, quickly increases the number of coefficients in the model, so theory and parsimony should be used in determining the lag length. Second, in order for the Hamas-Israel VAR to be identified, I need to impose one identification restriction.

In the next section, I discuss the lag specification tests and identification of the VAR model.

Model Specification

In order to choose an appropriate lag length, it is important to think not only about each side's short-term responses (i.e., within the first couple of hours) but also tactical shifts that may take up to a day to incorporate into outcomes. Israel might strike a Hamas rocket launching site an hour after an attack but respond tactically with preventative air strikes or ground raids much later. It is important to include enough lags to fully incorporate the short- and medium-term response to the initial provocation and prevent serial correlation (Enders 2004).

All models, plots, and accompanied statistics were calculated using the MSBVAR package in the R statistical software (Brandt and Appleby, 2007). With

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Table 2. Lag Length Specification Test

Lags	AIC	BIC	χ^2	p value (χ^2)
1	10.370	10.415	0.000	.000
2	10.356	10.432	15.525	.004
3	10.353	10.460	9.637	.047
4	10.353	10.490	7.998	.092
5	10.362	10.529	2.610	.625
6	10.366	10.564	5.610	.230
7	10.359	10.587	11.668	.020
8	10.352	10.611	11.534	.021
9	10.357	10.645	5.556	.235
10	10.379	10.688	0.902	.924
11	10.381	10.730	0.943	.918
12	10.387	10.766	4.566	.335
13	10.397	10.807	2.155	.707
14	10.400	10.840	6.080	.193
15	10.395	10.866	10.112	.039
16	10.400	10.900	4.896	.298
17	10.409	10.940	2.809	.574
18	10.409	10.970	7.444	.114
19	10.419	11.011	1.912	.752
20	10.427	11.050	2.902	.574
21	10.435	11.088	3.549	.471
22	10.438	11.122	5.531	.237
23	10.447	11.161	2.556	.635
24	10.451	11.195	5.361	.252
25	10.453	11.227	6.459	.167

hourly data, I use a lag specification test of up to 25 hours ($p = 25$), enough time to include a full-day response to the initial change in Hamas's or Israel's intensity.

The results of the lag specification tests are presented in Table 2.

The table shows that a case could be made for 5 lags as there is a small difference in the AIC between 3 and 5 lags and a larger difference between 5 and 6 lags. The p values of the χ^2 test also support a 5-lag model. However, it is also apparent that 9 lags might be a correct specification, as the AIC at 9 is lower than that at 5 and increases in value fairly quickly afterward (Brandt and Williams 2007). The IRF plots for the two models do not differ (Figure 2 compared to Figure C1[33]), so I choose the more parsimonious 5-lag model.

In order to identify and estimate the Hamas-Israel VAR with 5 lags, it is necessary to restrict the model. This is done by forcing either b_{12} or b_{21} to equal zero in Equations (1) and (2), which prevents either Hamas or Israel from reacting contemporaneously to the other (Enders 2004). There is evidence to suggest that Israel has the capacity to respond much more quickly to Hamas, than vice versa. Israel's military contains state-of-the-art equipment, laser-guided missiles and unmanned aerial

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vehicles (UAVs) able to strike and reconnoiter largely at will in Gaza (Israeli Defense Forces 2009b). Moreover, the IDF and Israel's security service, due to Israel's precarious relations with neighboring countries and various Palestinian groups (such as Hamas), have been built around the ability to rapidly respond to threats (*The New York Times* 2009). Hamas's capabilities do not match that of Israel for sophistication, organization, or manpower. There is also a strong reason to believe that Hamas's ability to respond militarily was impaired by Israeli military operations far greater than Hamas was able to affect Israel's ability to respond militarily. Finally, previous dynamic studies of Israel-Palestine conflict (Brandt, Colaresi, and Freeman 2008; Jaeger and Paserman 2006; Kavanagh 2009) have emphasized the greater responsiveness of Israel to Palestinian militant actions than vice versa. Therefore, I restrict Hamas to not respond contemporaneously to Israel. I do this by ordering Hamas first,[34] so that the Choleski decomposition method[35] restricts the upper-right-hand corner (b_{12}) to zero in the B matrix (and hence the A_0 matrix). I examine this identification restriction by testing the ordering of the variables in the decomposition of forecast error variance.

Finally, since a VAR system is an equilibrium representation, responses are calculated by examining how shocks propagate through the system. In other words, how does a surprise escalation by Hamas affect both Hamas and Israel and vice versa? Equation (3) can be expressed in terms of E_t, yielding the Vector Moving Average (VMA). The VMA centers the system around its equilibrium values and then tracks shocks as they move through the system and die out over time through IRF plots (Brandt and Williams 2007). IRF plots are an efficient way to present how Hamas and Israel respond to each other. If their IRF plots exhibit a similar pattern, then one could conclude that they respond in-kind to escalatory shocks. If their IRF plots differ, then this is evidence of an asymmetric response.

For VAR models, regression tables are not presented, as the joint behavior of the system and not individual coefficients are of interest (Brandt and Williams 2007). In the following section, I present the results of the 5-lag VAR model (Hamas initially constrained at zero) including tests of Granger causality, forecast error decomposition, and plots of the IRFs.

Results and Interpretation

Granger Causality and Forecast Error Variance

Using the the 5-lag VAR model as my specification, I test whether Israel and Hamas Granger cause each other.[36] The null hypothesis is whether the lagged coefficients (*Block Coefficient Restricted*) do not explain the *Hypothesized Exogenous Variable*.

Table 3 presents the results from the Granger Causality.

For both Granger Causality tests, the F-statistic is large enough to reject the null hypothesis. There is evidence that Israel depends on past values of Hamas and vice versa.

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Table 3. Granger Causality Tests for Hamas and Israel Based on the 5-Lag VAR Model

Hypothesized exogenous variable	Block coefficient restricted	*F*-statistic	*p* value
Israel	Hamas	3.041	0.010
Hamas	Israel	2.080	0.066

Note: VAR = vector autoregression.

Table 4 presents the forecast error decomposition.

It is useful to see how the fitted VAR model differs from the actual values and how these errors changes over time. Forecast error decomposition provides such a method using the orthogonalized vector moving average (VMA) representation to compute forecast errors over different time horizons (Brandt and Williams 2007). If Israel reacts more to Hamas than Hamas reacts to Israel, then following a shock to Hamas, a greater percentage of the forecast errors are due to innovations in Israel than the percentage of forecast errors due to innovations in Hamas following a shock to Israel. The second and third columns of Table 4 are the percentage of forecast error for the Hamas and Israel based on shocks to Hamas. The fourth and fifth columns give the percentage of forecast error for Hamas and Israel from a shock to Israel. As Hamas cannot react to Israel contemporaneously (by assumption), all of the error is placed on Israel in hour 1 (zero in column four for Hamas). After 12 hours and a shock to Israel, about 1 percent of the forecast error is attributed to innovations in Hamas. A shock to Hamas comparatively sees a much larger percentage of the variation in forecast error attributed to innovations in Israel. After 12 hours, close to 19 percent of the forecast error is attributed to innovations in Israel.[37]

The forecast error decomposition indicates that Israel was reacting more to Hamas than vice versa. This supports the underlying theories of guerilla conflict—where a smaller force embedded in a local population (Hamas) avoids direct confrontation with the stronger actor (US Army and Marine Corps 2007). Another interpretation offered by an IDF official is, ''There was never a single incident in which a unit of Hamas confronted our soldiers ... we kept waiting for them to use sophisticated antitank and antiaircraft missiles against us, but they never did'' (McGirk and Klein 2009).

Impulse Response Analysis

The IRF plots are constructed from the VMA representation and trace the effect of a one standard deviation shock in the residuals of the estimated 5-lag VAR model (Hamas constrained at zero).[38] For instance, if one were looking to see the effect that a shock in Hamas had on Israel, one would take the standard deviation of the residuals in the Hamas VAR equation. To ease interpretation, I normalize all residuals to 1, so all responses are in proportion to the original shock. Figure 2 is the IRF plot for Hamas and Israel sampled from the full 598 hours of the conflict.

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Table 4. Decomposition of the Forecast Error Variance for 5-Lag VAR Model (Hamas Constrained at Zero)

	Forecast error % for shock to Hamas		Forecast error % for shock to Israel	
Hours	Hamas	Israel	Hamas	Israel
1	87.715	12.284	0.000	100.000
2	84.630	15.370	0.847	99.153
3	84.200	15.800	0.933	99.067
4	83.624	16.376	0.953	99.047
5	83.122	16.878	0.945	99.055
6	82.368	17.632	1.027	98.973
7	81.969	18.031	1.053	98.947
8	81.753	18.247	1.064	98.936
9	81.612	18.388	1.069	98.931
10	81.505	18.495	1.077	98.923
11	81.434	18.566	1.082	98.918
12	81.390	18.610	1.085	98.915

The columns in the 2×2 plots above represent the actor that propagates the shock and the rows are the actor that responds to the shock. The solid line is the IRF. The dashed red lines represent 95 percent confidence intervals derived from $10,000$ Monte Carlo simulations MSBVAR. The on-diagonal (upper left and bottom right) plot the shocks in Hamas and Israel and their self-response. The response to a shock in their own values causes a relatively steep initial response that dies out rather quickly.[39] This logically makes sense, as self-induced shocks should not change actors' behavior. Hamas's reaction to a shock in Israel (upper right) is initially constrained at zero. Recall that this is a modeling assumption—Hamas cannot react contemporaneously to Israel. In comparing Israel's reaction to a Hamas shock (bottom left) to Hamas to a shock in Israel, it is apparent that Israel reacts stronger initially. Israeli response is greater than 0, whereas Hamas's dips below the 0 on the *y*-axis after the second hour.

There may be a worry that the level of aggregation (hourly) "misses" Hamas reactions. While Israel reacts relatively quickly to Hamas escalations, Hamas may take much longer (up to 48–72 hours) to react to Israel. Thus, the fine level of analysis presented biases towards a null finding for Hamas. I test this by aggregating the data to 6-hour levels and recheck the results from Figure 2 (results in the Appendix). The asymmetric response dynamic, with Israel strongly reacting to a Hamas shock and Hamas not reacting in a significant way toward Israel, is still evident and further strengthens the findings.[40]

Given that I am interested in how Hamas and Israeli responses change across the conflict, I subset the data before and after important change-points in the conflict and apply the same 5-lag VAR specification as I did for the full model.[41] I then investigate whether the Israel and Hamas IRFs change with Ground Invasion and the

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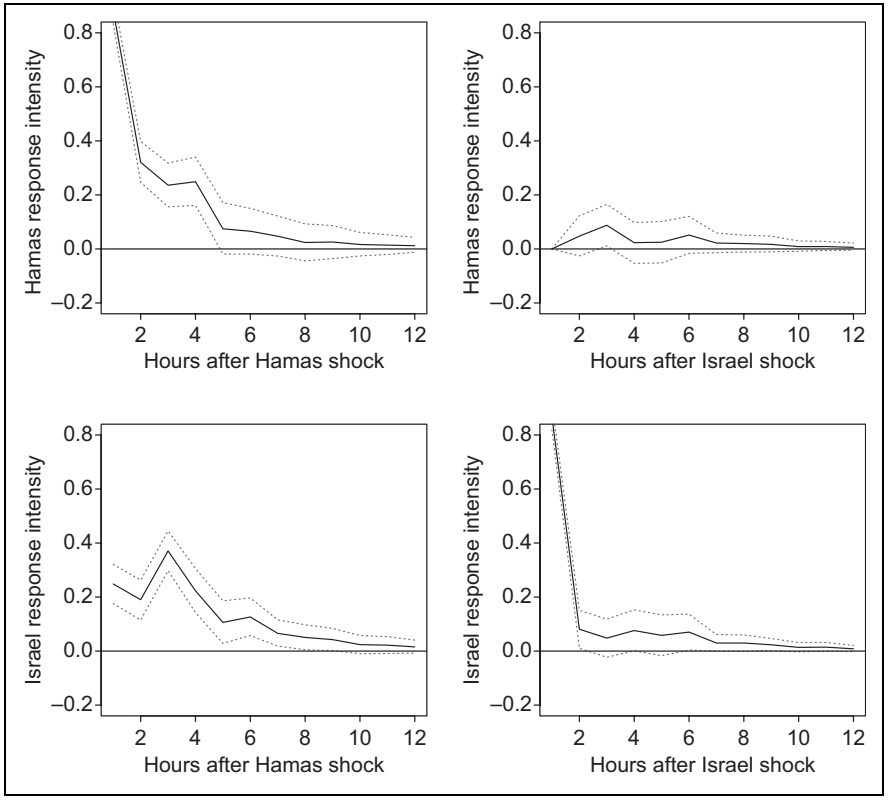

Figure 2. Impulse response analysis for the whole duration of the conflict

UN Security Council Vote. The IRF plots for the Pre- and Post-Invasion are in Figures 3 and 4.[42]

It is interesting to compare the plots in Figure 3 to those in Figure 4. *Pre-Invasion*, Hamas's reaction to Israel contain larger confidence intervals and are less measured. *Post-Invasion*, Hamas reactions are more predictable, with a lower probability of large negative and large positive responses to Israeli provocations. Hamas is somewhat less predictable in its response to Israeli escalation before IDF troops enter Gaza. It might be of concern that the number of data points from which I am sampling the IRF on *Pre-Invasion* is only 173 compared to 425 in the *Post-Ground Invasion* and that this is driving the confidence interval difference. However, in looking at the Israeli plots in Figures 3 and 4, it is apparent that this is not necessarily the case. Israel's IRF to a Hamas shock, while more erratic, still contains fairly tight confidence intervals. Israel's Pre-Invasion response to a surprise Hamas escalation indicates a less coherent response pattern, whereby escalatory shocks in Hamas's behavior are met with strong initial

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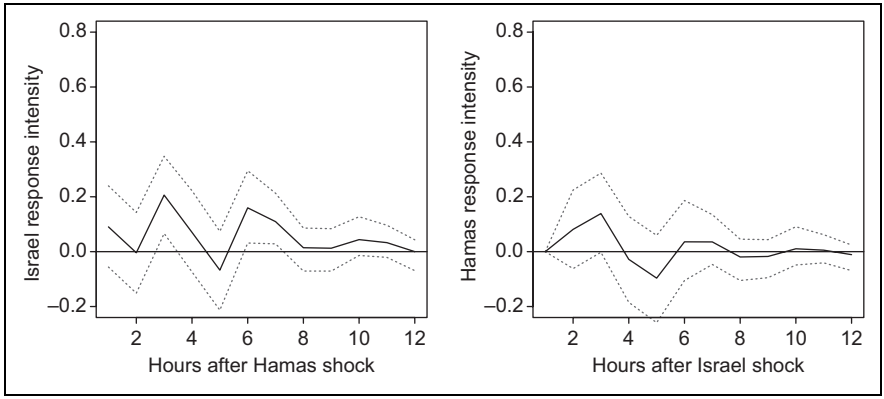

Figure 3. Impulse response analysis for the pre-invasion phase (first 173 hours)

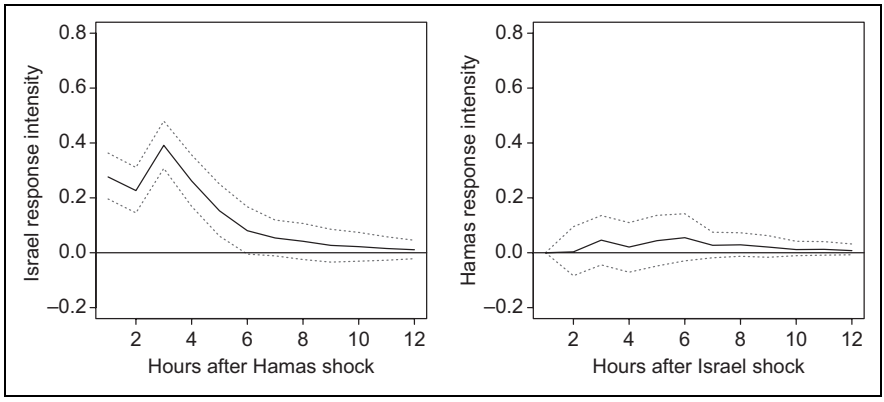

Figure 4. Impulse response analysis for the post-invasion phase (174th hour and after)

responses, then oscillating responses of deescalation and escalation. *Post-Invasion*, Israel's response is much smoother and coherent.

The results partially support the conclusions of the "boots on the ground" hypothesis. Having troops on the ground facilitates an increased Israeli targeting of Hamas (the smoother IRF *Post-Invasion*). However, the "boots on the ground" hypothesis would also suggest a lower Israeli response *Post-Invasion*, as a ground presence facilitates more precise targeting with smaller arms. Figure 4 shows an increase Israeli reaction *Post-Invasion*. This can be partly attributed to the IDF's rules of engagement when responding to Hamas attacks, with IDF troops maneuvering and returning fire behind heavy tanks and/or helicopter support. Additionally, Hamas's response *Post-Invasion* is more certain

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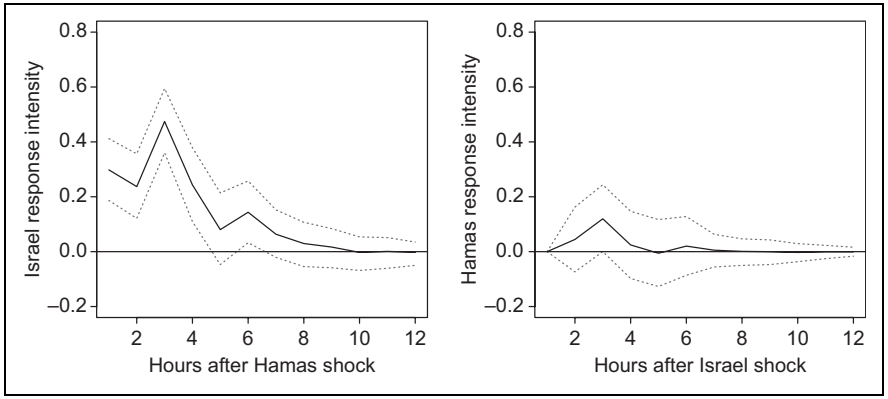

Figure 5. Impulse response analysis for the Pre-UN Security Council vote (first 305 hours)

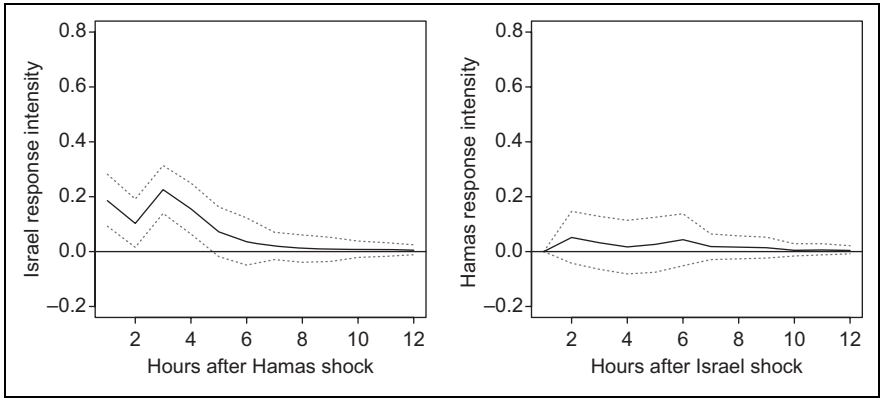

Figure 6. Impulse response analysis for the Post-UN Security Council vote (306th hour and after)

(tighter confidence bands), its most violent response is lower (the height on the upper confidence band) but on average is higher. The Israeli ground invasion affords Israel more precise targeting and response to Hamas attacks, a greater certainty about Hamas's actions, but also affords Hamas the ability to respond more to Israel (higher average response).

Figures 5 and 6 plot the IRF for the Pre and Post-UN Security Council Vote.

It appears that the Security Council resolution marked a larger turning point for Israel than for Hamas. Israel's initial reaction to a Hamas shock is more muted *Post-UN Vote* (lower *y*-intercept). Hamas's IRF does not shift down at all, in fact it slightly moves up. This does not necessarily imply that Israel was more responsive to the UN resolution. It could be that the UN waited until it felt

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Table 5. Cumulative Impulse Responses Given a 1 Unit Shock

Shock in	Period	Response by	Response magnitude after 12 hours	95 CI
Israel	Whole Conflict	Hamas	0.32	(−0.20, 0.84)
Israel	Pre-Invasion	Hamas	0.13	(−1.02, 1.28)
Israel	Post-Invasion	Hamas	0.28	(−0.35, 0.94)
Israel	Pre-UN Vote	Hamas	0.21	(−0.61, 1.02)
Israel	Post-UN Vote	Hamas	0.24	(−0.41, 0.91)
Hamas	Whole Conflict	Israel	1.49	(0.83, 2.16)
Hamas	Pre-Invasion	Israel	0.66	(−0.61, 1.96)
Hamas	Post-Invasion	Israel	1.56	(0.71, 2.41)
Hamas	Pre-UN Vote	Israel	1.58	(0.44, 2.69)
Hamas	Post-UN Vote	Israel	0.84	(0.06, 1.60)

Note: 95 percent confidence intervals (CI) calculated from 10,000 Monte Carlo simulations using the MSBVAR package in R.

that Israel was largely finished with its ground operations to insure the appearance of "compliance" with the resolution. The pressure placed on Israel by the UN can be viewed as a higher cost to Israel of continued Palestinian casualties. The cost to Hamas (in terms of civilian casualties) of continuing to fire on Israel may have also increased. However, their (Hamas's) lack of a reaction *Post-UN Vote* suggests that this increase may be offset by the smaller chance of an Israel response to an attack (i.e., they can attack Israel with greater impunity). Examples of this asymmetric response dynamic *Post-UN Vote* are the Hamas initiated shooting incident and rocket attacks that occurred on January 20, 2009, just as Israel was in the midst of pulling out of Gaza (*AJGaza* 2009; *The Muqata* 2009).

The Cumulative IRF functions are reported in Table 5. They are the cumulative effect of the shock after 12 hours.

In sampling over the full 598 hours of the conflict, Israel's cumulative reaction to Hamas after 12 hours is on average (i.e., midway between the upper and lower 95 percent) five times as strong (1.49/0.32) as a Hamas response.[43] Furthermore, Israel's cumulative response is bigger than Hamas's in every phase of the conflict. *Post-Invasion*, both Israel's and Hamas's response to a shock by the other increase by about twofold (2.36 times for Israel 2.15 times for Hamas). Additionally, *Post-UN Vote* Israel's response magnitude decreases by almost a half (47 percent decrease) while Hamas's average response actually slightly increases (by about 14 percent). Another interesting observation is the smaller confidence intervals on the Hamas cumulative IRF *Post-Ground Invasion* compared to *Pre-Invasion*. The size of the confidence intervals can be viewed as a measure of Israeli certainty about Hamas's actions. I measure certainty as the difference between the highest and lowest values in the 95 percent confidence interval. The extra certainty gained by Israel *Post-Invasion* is quite substantial (44 percent).

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Implications

The variability in the IRFs quantifies the effects of international institutions and having troops on the ground on conflict response dynamics and offers some new insights: the Israeli ground invasion increases Hamas's and Israel's average response but also increased Israeli certainty about Hamas's action, and the UN decreases Israel's response to a Hamas escalation but does not affect Hamas. A cursory conclusion from the cumulative IRF analysis would seem to suggest that Israel reacts to a greater extent *Post-Invasion* and therefore uses greater force. However, it is important to have some context when interpreting the IRF plots. The IRF analysis does not measure the conflict intensity itself but rather each sides' reactions to surprise attacks by the other. For example, if Israel was bombarding Hamas throughout the conflict and not reacting to Hamas, one would observe an Israeli IRF (with respect to Hamas) that does not appear to be very reactive. The increase in Israel's IRF *Post-Invasion* may be due to Israel reacting more to Hamas and actually using more measured force (infantry and close-quarter tactics as opposed to artillery shelling and widespread bombing) when reacting to Hamas provocation. However, this explanation does not completely mesh with the facts on the ground. The UK newspaper, *The Guardian*, created a map and timeline of the casualties throughout the Gaza Conflict.[44] The casualty reports show that while significant Palestinian casualties occurred in the opening days of IAF bombing campaign, more than half of the 1,300 killed came after the ground invasion. This supports the explanation that Israel's ground invasion allowed Israel to respond more coherently to Hamas, but that the cautious, liberal use of IDF firepower, per the rules of engagement, did not lead to a more "proportional" response.

From anecdotal evidence and the IRF analysis, the Israeli ground invasion seems to have dampened Hamas's unpredictability. However, whether Hamas chose not to directly confront IDF in pitched battles, or was tactically unable to, is a matter still open to debate. The results do seem to reject the notion that Israel was able to completely dictate Hamas's ability to react (i.e., their military superiority completely swamps Hamas's tactics). This finding meshes with Kavanagh (2009) and Haushofer, Biletzki, and Kanwisher (2010) who show that Israel's counterterror operations have limited effects in of decreasing Palestinian reactions. Furthermore, in asymmetric warfare, a central tenet is using alternative (any) means to defeat a stronger enemy. Hamas was one of the early advocates of suicide attacks as a way to circumvent precisely this Israeli force superiority. The Israeli ground invasion may have allowed Hamas to use its knowledge of terrain and the populace to its advantage to stymie Israel's ability to completely dictate the terms of engagement. While Hamas may not have been able to fire as many rockets *Post-Invasion*, it had increased opportunities to ambush and use unconventional (suicide attacks/kidnappings) against IDF soldiers. The certainty the IDF gained *Post-Invasion* (an extra 44 percent) about Hamas's reactions may be more significant. Yet, Hamas rocket fire and attempted ambush of Israeli soldiers toward the end of the conflict suggest that increased "certainty" about Hamas's reaction *Post-Invasion* may have been a short-lived phenomenon, rather than a sustained victory by Israel.

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It is important to also point out the asymmetric impact that international pressure (*Post-UN Vote*) had on Hamas's and Israel's responses. Israel's ability to respond to a Hamas escalation is significantly reduced by the UN Security Council resolution, whereas Hamas's slightly increases. This may be an artifact of the UN waiting until the conflict died down before putting forth a resolution. However, international pressure to minimize civilian casualties constrained the IDF's ability to use their full arsenal to target Hamas. The shelling outside of a UNRWA school housing civilians (Al-Fakhura School) by IDF mortars on the eleventh day of the conflict, conveys the different international pressure placed on Israel and Hamas as they conducted military operations.

On January 6, 2009, IDF troops operating in northern Gaza attempted to take out a Hamas mortar team firing near[45] the UNRWA school housing some 400 civilians taking refuge from the conflict (McGirk 2009). The IDF was aware that the UNRWA school housed a large number of civilians (El-Khodary and Kershner 2009). The IDF troops used a global position satellite (GPS) mortar system to target and fire at the militants. The GPS mortar system had a margin of error of 30 meters. The IDF fired three mortars. Two hit their intended target and a third strayed into the adjacent UNRWA school courtyard where a number of civilians were gathered (Harel 2009; Israeli Defense Forces 2009a). Initial reports from UNRWA and Hamas officials claimed that the school had received a direct hit. However, the UN eventually backed away from this statement (McGirk 2009). The exact number of civilian casualties remains disputed with the UN stating that up to forty civilians were killed and Israel arguing that only three civilians were killed along with nine Hamas members (Israeli Defense Forces 2009a; McGirk 2009).

The IDF mortar strike was met with widespread condemnation by the UN and international community (El-Khodary and Kershner 2009). Many observers argued that the Al-Fakhura incident helped galvanize public opinion and international pressure on Israel for a cease-fire in operations and the UN Security Council vote that occurred two days afterward (El-Khodary and Kershner 2009). While the cease-fire would not take place for another two weeks, the media coverage and perceived Israeli disregard for civilians near the school highlight the difficulties the Israelis faced in confronting Hamas in a conflict fought among a civilian population.

Future Research

In exploiting new data sources on short-term conflict dynamics between a strong and weak actor, this article contributes to the literature on the role institutions—both international and domestic—play in shaping and constraining actors during conflict. It also represents a first step in untangling the complicated dynamics at work in asymmetric conflict fought by strategic actors. Improved measurement of conflict intensity is needed to more accurately scale and empirically test models of conflict. Both Israel's and Hamas's decisions on whether or not to escalate were partly based on domestic political concerns, such as Hamas's popularity relative to Fatah and the

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February 2009 Israeli election. If possible, inclusion of these factors could further yield important information on the connection between domestic concerns and international conflict intensity.

As Signorino (1999) and Bas, Signorino, and Walker (2008) show, the recovery of strategic interaction in conflict through statistical analysis merits special attention. Hamas and Israel are not static actors, but dynamic, strategic actors. The UNRWA school controversy is an example of how an actor (Hamas) adapts (firing near civilian refugees) to negate a perceived advantage (the IDF's superior ground capabilities). A framework for empirically capturing this dynamic in a strategic context would improve the underlying test of the theory. Additionally, the incorporation of the recent work of Brandt (2009) on international conflict and Markov processes (MSBVAR) and refinement of testing for structural changes (Park 2010) could prove valuable in teasing out additional conflict dynamics.

It is important to also highlight the opportunities that new data sources, such as social media, present to improve measurement and understanding of conflict processes. However, scholars must be cognizant of the limitations of such data, especially when editorial intervention interferes in the data generating process. Further work on building a paradigm to incorporate social media sources along with mainstream media sources may also prove fruitful.

Finally, as many pundits have noted,[46] traditional, all-out war between nation-states is partly being replaced by multidimensional conflict (cyberwarfare, transnational terrorism, etc.). The recent Gaza Conflict represents a particularly pertinent example. Greater attention to additional dimensions of conflict and their implications is needed to better understand the threats nations and groups will face in the immediate future.

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Appendix A: Conflict Intensity Scores

Table A1. Conflict Intensity Coding Scheme

Score	Action taken	Definition/scope
0	No action taken	
1	Cease-fire	
2	Investigate	
3	Demand	
4	Reject	
5	Admonish	
6	Protest	
7	Threaten/heightened alert	Use of threats or provocations
8	Reduce relations	
9	Engage militarily	Hamas action when invasion begins
10	Occupation	Israeli action when ground fighting begins
11	Misinformation	Psy-Ops, Cyber Warfare
12	Sporadic mortar rocket fire	Intention to harass
13	Endangering civilians	Use of human shields, intentionally endangering a civilian population
14	Large-scale/longer range rockets	Use of Grad and/or multiple rockets
15	Unconventional tactics	Improvised explosive devices/ suicide attacks etc.
16	Limited/targeted air strikes	Assassination, specific targets (small collateral damage)
17	Limited ground forces	Small unit firefights/special forces/ambushes
18	Artillery fire	Tank and other artillery batteries
19	Large ground forces	Movement of large infantry and mech. divisions
20	Widespread air strikes	Large collateral damage/attacks infrastructure

Appendix B: Forecast Error Decomposition

Table B1. Decomposition of the Forecast Error Variance for 5-Lag VAR Model (Israel Constrained at Zero)

	Forecast error % for shock to Hamas		Forecast error % for shock to Israel	
Hours	Hamas	Israel	Hamas	Israel
1	100.000	0.000	3.932	96.068
2	97.968	2.032	5.918	94.082
3	97.090	2.910	5.914	94.086
4	96.518	3.482	6.032	93.968
5	96.073	3.927	6.051	93.949
6	95.461	4.539	6.021	93.799
7	95.069	4.931	6.268	93.732
8	94.830	5.170	6.299	93.700
9	94.679	5.321	6.316	93.684
10	94.568	5.432	6.331	93.669
11	94.494	5.506	6.342	93.658
12	94.447	5.553	6.348	93.652

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Appendix C: IRF Plots For the Whole Conflict 9-Lag Model

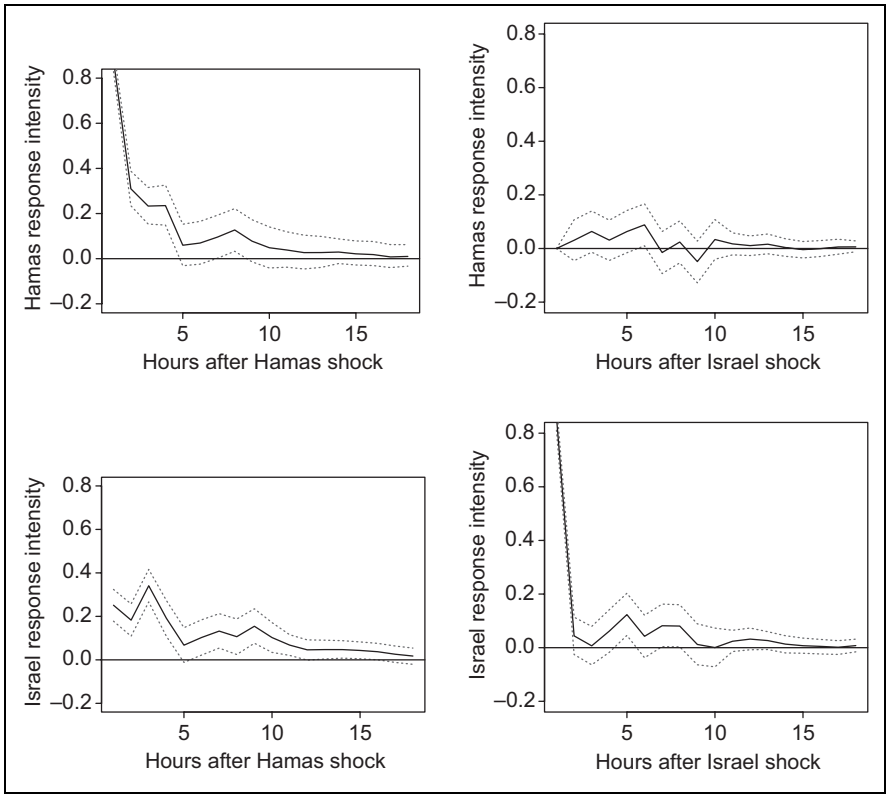

Figure C1. Impulse response analysis for the 9-lag VAR model over the whole conflict

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Appendix D: Aggregation at the 6-Hour Level

Lag Length 6-Hour Level

Table D1. Lag Length Specification Test 6-Hour Aggregation

Lags	AIC	BIC	χ^2	*p* Value (χ^2)
1	15.623	15.791	0.000	.000
2	15.589	15.870	10.356	.035
3	15.463	15.857	17.535	.002
4	15.535	16.042	1.488	.829
5	15.611	16.230	1.194	.879
6	15.643	16.375	4.365	.359
7	15.647	16.491	6.392	.172
8	15.610	16.567	11.534	.059
9	15.657	16.727	2.985	.560
10	15.716	16.898	2.156	.707
11	15.786	17.081	1.380	.848
12	15.847	17.255	1.840	.765

Forecast Error Decomposition (Hamas Constrained at Zero) 6-Hour Aggregation

Table D2. Decomposition of the Forecast Error Variance for 4-Lag VAR Model (Hamas Constrained at Zero) 6-Hour Aggregation

	Forecast error % for shock to Hamas		Forecast error % for shock to Israel	
Hours	Hamas	Israel	Hamas	Israel
1	74.453	25.547	0.000	100.000
2	68.202	31.798	1.535	98.465
3	62.156	37.844	2.710	97.290
4	62.272	37.728	2.836	97.164
5	63.817	36.183	2.901	97.099
6	63.585	36.415	3.227	96.773
7	63.519	36.481	3.239	96.761
8	63.564	36.436	3.238	96.762
9	63.661	36.339	3.251	96.749
10	63.658	36.342	3.266	96.734
11	63.655	36.345	3.268	96.732
12	63.661	36.339	3.268	96.732

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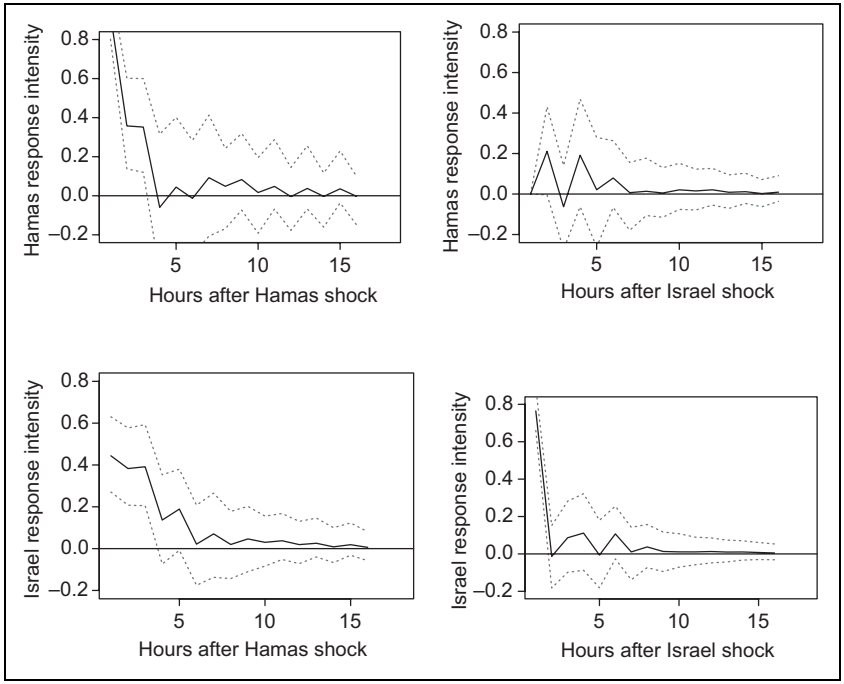

Figure D1. Impulse response analysis for a 4-lag vector autoregression model over the whole conflict aggregated at 6-hour limit

Appendix E: Test of Subsetting the Data

Table E1. χ^2 Test for Structural Break with UN Security Council Vote

	Pre-UN Vote	Post-UN Vote	Pooled
log (ℓ)	−2457.803	−2216.242	−4743.517
χ^2	127.776		
df	22		
Critical value	40.29	p = .01	

Table E2. χ^2 Test for Structural Break with the Israeli Ground Invasion

	Pre-Invasion	Post-Invasion	Pooled
log (ℓ)	−1344.938	−3322.305	−4743.517
χ^2	141.38		
df	22		
Critical value	40.29	p = .01	

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Notes

1. Dahiya referes to a Shiite-dominated quarter of Beirut that was heavily bombed by the Israel Air Force during the 2006 Lebanon War.
2. See for example the prominent use in Political Science *The Correlates of War,* http://www.correlatesofwar.org/database.
3. See Steven Metz's 2000 report *Armed Conflict in the 21st Century: The Information Revolution and Post-Modern Warfare* for an overview of the new role technology in the speed of conflict.
4. I am grateful for an anonymous reviewer pointing this out.
5. For instance, see the international dimensions of May 31, 2010, Israeli raid on ships carrying aid and humanitarian activists bound for Gaza, http://www.nytimes.com/2010/06/01/world/middleeast/01flotilla.html.
6. In addition to the short-term dynamics that differentiate my work from the others, with the exception of Brandt, Colaresi, and Freeman (2008), the other studies rely on casualty counts, while I use of conflict intensity scores to measure reciprocity. Tactical decisions to escalate or de-escalate are correlated with casualty counts—however not perfectly. A bomb or missile may miss or hit its target by inches or feet resulting in fewer or more casualties than expected. Actors have control over what kind of tactics to use, but there is a random element to the amount of casualties those tactical decisions will inflict. Thus, tactical decisions to escalate may better measure underlying reciprocity.
7. Davenport (2007, 18) highlights the need for disaggregated data repression data, as the temporal aggregation masks important policy changes that occur at the subyear level.
8. United Nations Relief and Works Agency for Palestine Refugees in the Near East.
9. See www.israelemb.org/ for more information.
10. Most of the rockets fired into Israel are of the "homemade" Qassam variety with a range of 3 to 12 kilometers and are highly inaccurate. However, the longer-range Grad rocket has a range of 18 to 20 kilometers and is manufactured by the Iranians. See www.globalsecurity.org/military/world/para/hamas-qassam.htm.

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11. Hamas's stated reason for ending the cease-fire was the strict Israeli blockade imposed upon goods into the Gaza Strip.
12. Several ranking military leaders in Hamas were assassinated in the opening days of the conflict, most notably Nizar Rayan, a high-ranking military and political commander, on the fifth day of the conflict (*AJGaza* 2009).
13. Many Israeli observers were worried about Hamas obtaining longer-range rockets that were allegedly being smuggled in through tunnels from Egypt from Iran with the capability of striking deeper into Israel.
14. The fiercer fighting occurred in Gaza.
15. Given the political struggles between Hamas and Fatah, several pundits have argued that Hamas was banking on a strong Israeli response to their increased rocket fire (Hass 2009; *The Economist* 2009). This in turn would put Fatah in an awkward place, as they would have to support the Palestinians (and hence Hamas) against Israeli aggression. By engaging Israel militarily before the election, Hamas may have been hoping to marginalize Fatah and insure their own domestic political support (Bueno de Mesquita and Dickson 2007).
16. These conditions were imposed by the "Madrid Quartet" made up of Russia, the United States, the United Nations, and the European Union, as a precondition for diplomatic normality.
17. When they received hostile fire, the IDF troops would call in artillery and air support and then maneuver behind the tanks and armored personnel carriers (Erlanger 2009). Additionally, when entering suspicious buildings, the IDF blasted through a side wall and not the front entrance to avoid booby traps (Erlanger 2009). The IDF employed the same technique when moving within the building—avoiding door entrances and instead using explosives to enter through a side wall.
18. An alternative view is that Hamas had no coherent military strategy to the IDF. The sporadic resistance it posed to the IDF was a symptom of its disorganization, rather than a coherent strategy. For example, see www.economist.com/node/15913000?story_id=15913000 fsrc=rss.
19. See www.usatoday.com/news/world/2009-01-19-israel-gaza-monday_N.htm.
20. Both Hamas and Israel utilized these tools to get their point of view across and, in some, cases intimidate the other side. Hamas sent text messages to random Israeli numbers warning them of large scale-rocket attacks. Meanwhile, IDF called residents warning them that they had minutes to evacuate because there was a bomb in their house. See www.guardian.co.uk/world/2009/jan/03/israelandthepalestinians-middleeast for the full story. Both sides also extensively used Internet media through various Facebook groups to encourage solidarity among sympathizers. For more information see www.time.com/time/world/article/0,8599,1871302,00.html.
21. Such as protests, dissident activities, and war crimes. With respect to the Gaza Conflict, see the contentious nature of the *Report of the United Nations Fact Finding Mission on the Gaza Conflict* (also known as the "The Goldstone Report"), www.nytimes.com/2010/01/24/world/middleeast/24goldstone.html.
22. The namesake comes from an Akira Kurosowa film of the same name in which the same story is told from five different perspectives, with very different interpretations.

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23. Ushahidi is a platform that allows for researchers and organizations to track information and violence in conflict zones using a computer platform and SMS messages. For more information visit www.ushahidi.com/.
24. See http://labs.aljazeera.net/warongaza/.
25. Another Jewish/Israeli newspaper that kept copious track of the rocket fire. See www .ynetnews.com/home/0,7340,L-3083,00.html.
26. See http://news.bbc.co.uk/2/hi/middle_east/7812136.stm.
27. This is consistent with Almeida and Lichbach (2003) findings.
28. In this example, Hamas's event score would be a 17 for "limited ground forces," whereas Israel would be scored a 19 for "large-scale ground forces." In some sense, Hamas is constrained by the fact that it does not possess tanks, and large-scale infantry, so one would not observe Hamas involved in large-scale firefight or engaged aerial bombardment. Thus, its response is constrained below 19. One might be concerned that Hamas could never respond as strong as Israel by convention. However, because I aggregate the data to the hour level, this is not always the case. Moreover, this constraint on Hamas is simply a fact of asymmetric warfare.
29. It would be preferable to have machine coded the events using software such as the Kansas Events Data System http://web.ku.edu/ keds/. However, the structure of the Twitter feeds and *The Muqata* blog updates—with embedded links and reports that corrected—were not in an easily digestible format like a Reuters news article (the original impetus behind machine-coded events data). This made hand-coding preferable.
30. This happened very rarely.
31. I ran the VAR analysis at the 15-minute interval level with a log transformation of the Hamas and Israel series to account for the non-normality of the data. I find that the results are not that different than the aggregated ones, so the temporal aggregation does not appear to be problematic.
32. Whenever coding content analysis, it is necessary to provide a measure of intercoder reliability. On a subset of the data, I measured my coded responses against those of another coder using the framework in the Appendix. I found that we had 84% agreement. Cohen's (1960) κ, a more robust measure of intercoder reliability, was .76. When $.61 \leq \kappa \leq .80$, this indicates substantial agreement (Landis and Koch, 1977). It should also be pointed out that Cohen's κ probably understates the level of agreement, as it is biased against the inclusion of larger numbers of categories.
33. The impulse response function plots for 9-lag model can be found in the Appendix.
34. This is the default setting in the MSBVAR package in R. The order of the variables "forces" the structure upon the system by constraining the leading column variable (Hamas) to not react contemporaneously (to Israel) for the system to be identified.
35. For further discussion of the Choleski decomposition method, see Enders (2004).
36. Granger causality does not imply causality in the strict sense. Rather, it shows that past Hamas actions are useful for predicting Israel actions and vice versa. For a more detailed discussion of issues surrounding Granger causality and VAR, see Brandt (2006; Brandt and Williams 2007).

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37. Some might be concerned that the identification restriction is imposing the forecast error result of Israel being more reactive to Hamas than vice versa. I reran the decomposition of forecast error variance with Israel not being able to react contemporaneously to Hamas. Given a shock to Israel, after 12 hours, about 6.3 percent of the forecast error is attributed to Hamas. After 12 hours, about 5.5 percent of the forecast error for a shock to Hamas is attributed to Israel. While the results change given the reverse constraint, Hamas is approximately as reactive to Israel as vice versa. This suggests that constraining Hamas by the Choleski Decomposition, is fairly robust.
38. Plots for the 9-lag VAR model are presented in the Appendix for comparison.
39. For the rest of IRF plots, I omit these plots of self-response for the rest of the IRF analysis (UN vote and ground invasion) as they all resemble those in Figure 2. The more interesting plots as far as testing my hypotheses are those that show IRF for Hamas to shocks in Israel and vice versa. All self-reaction plots closely resemble those in the on-diagonal plots in Figure 2.
40. Given that there are only 100 data points after aggregating at the 6-hour level, there are not enough observations to subset the data as is done for Figures 3 through 6.
41. The lag specification tests for the subsets of the data mirror those of the full data. The tests support a 5-lag model for all subsets of the data.
42. It may be inappropriate to subset the data and then analyze how IRF plots change if there is a not a statistically significant difference in the VAR model before and after the change-points (Park 2010). I rerun my 5-lag model including testing for a structural break after the *Ground Invasion* and *UN Security Council* Vote using the log likelihood ($\log(\ell)$) from the VAR system fitted using vars package in R (the MSBVAR package does not provide the log likelihood). To test for a structural break on the UN Security Council Vote, I fit a VAR on both subsets of the data $\log(\ell)_{\text{pre.un}}$ and $\log(\ell)_{\text{post.un}}$) and on the pooled data $\log(\ell)_{\text{pooled}}$. The associated statistic is $\tilde{\chi}^2 = 2[(\log(\ell)_{\text{pre.un}} + \log(\ell)_{\text{post.un}}) - \log(\ell)_{\text{pooled}}]$ with K degrees of freedom. The same formula holds for testing for a structural break on the ground invasion. The test statistics for both the *Ground Invasion* and *UN Security Council* vote are sufficiently large to reject the null hypothesis of no structural break (see Tables D1 and D2 in Appendix D). For a recent, more sophisticated treatment of Markov processes and structural breaks in dynamic multiple time series, see Brandt (2009).
43. As noted previously, this quantification of five times stronger is dependent on the ordinal coding scheme. A different coding scheme might yield a stronger response by making the intensity assigned to a targeted air strike (16) more than just 2 higher than a rocket attack (14). There is little evidence to suggest that I have "overstated" the magnitude difference, as I used a very conservative (1 unit shift between higher-intensity events). The benefits of being able to discuss magnitudes of response are useful as long as the reader remembers that it refers to my coding scheme.
44. www.mapmash.in/gaza.html.
45. IDF forces initially claimed that the militants were firing actually from the school (McGirk 2009). However, UN officials and Hamas deny the fact that militants were firing from the school and instead stated they were firing from a courtyard across the street (El-

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Khodary and Kershner 2009). The Israel officials eventually backed away from their initial statements and in a follow-up investigation said that the Hamas mortar team was 80 meters from the school in a courtyard (Harel 2009).

46. See *Danger Room's* blog entry "How to Win a Fifth-Generation War" http://www.wired.com/dangerroom/2009/01/how-to-win-a-fi/.

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