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The Cycle of Violence?

An Empirical Analysis of Fatalities in the Palestinian-Israeli Conflict

David A. Jaeger • M. Daniele Paserman

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The Samuel Neaman Institute
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THE CYCLE OF VIOLENCE? AN EMPIRICAL ANALYSIS OF FATALITIES IN THE PALESTINIAN-ISRAELI CONFLICT

David A. Jaeger
College of William and Mary and IZA
djaeger@wm.edu

and

M. Daniele Paserman
Hebrew University, CEPR, and IZA
dpaserma@shum.huji.ac.il

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THE CYCLE OF VIOLENCE? AN EMPIRICAL ANALYSIS OF FATALITIES IN THE PALESTINIAN-ISRAELI CONFLICT

Abstract

This paper studies the dynamics of violence in the Palestinian-Israeli conflict since the outbreak of the Second (or "Al-Aqsa") Intifada in September 2000, during which more than 3,800 Palestinians and more than 1,000 Israelis have been killed. The conflict has followed an uneven pattern, with periods of high levels of realized violence and periods of relative calm. Using data on the number of deaths occurring each day between September 2000 and January 2005, we estimate reaction functions for both Israelis and Palestinians and find evidence of unidirectional Granger causality from Palestinian violence to Israeli violence, but not vice versa. This finding is consistent whether we look only at the incidence of fatalities or whether we look at the level of fatalities, and is robust to the specification of the lag structure and the level of time aggregation. We find little evidence that violence on either side has a direct deterrent or incapacitation effect, or that elevated intended Palestinian violence follows from previous Palestinian fatalities. We conclude that, despite the popular perception that Palestinians and Israelis are engaged in "tit-for-tat" violence, there is no evidence to support that notion.

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The most recent outburst of the Palestinian-Israeli conflict, commonly known as the Second, or "Al-Aqsa", Intifada, has claimed the lives of more than 3,800 Palestinians and more than 1,000 Israelis since its outbreak in September 2000.[1] This eruption of violence has been accompanied by a severe economic crisis, both in Israel and in the Palestinian Authority-administered territories in the West Bank and Gaza.[2] Repeated attempts to broker a stable ceasefire have failed, and the conflict has often been characterized as a vicious cycle of violence from which it is impossible to escape.[3] This view suggests that the dynamics of the conflict are governed primarily by a vengeance motive, and that any act of violence will lead to a spiral of retaliation and counter-retaliation that cannot be broken. It is possible, however, that violence by one side may deter the opposite side from engaging in violence. Similarly, violence could also have an incapacitation effect. For example, military operations conducted by the Israel Defense Forces (IDF) against suspected terrorists and militants may lead to a reduction in violence, to the extent that they limit the operational capabilities of Palestinian groups to carry out attacks against Israeli targets. The question of whether military operations are effective and whether their timing is chosen appropriately has been at the center of the public debate in Israel, but little serious and convincing evidence has been provided to settle the issue.

In this paper we explicitly address these issues by examining whether violence against Israelis and Palestinians affects the incidence and intensity of each side's reaction. We test empirically whether the pattern of violence in the current conflict should indeed be characterized

[1] The figures for fatalities are current as of 1 November 2006.

[2] Israeli GDP per capita shrunk by about 6 percent in Israel between 2000 and 2002 in local currency terms, and by 19 percent in dollar terms (source: Bank of Israel, 2003). Palestinian Gross National Income per capita fell by 46 percent between 1999 and 2002 (The World Bank, 2003).

[3] For example, here are some reactions to the suicide bombing attack at the Dolphin disco in Tel Aviv on June 1, 2001. "U.N. Secretary-General Kofi Annan […] condemns this indiscriminate terrorist attack […]. This […] event underlines the urgency of breaking the *cycle of violence*." (UN Secretary-General press release, June 1, 2001). "The Presidency of the European Union […] appeals to Israel not to take measures which result in a further escalation of the *cycle of violence*." (European Union press release, June 2, 2001). The emphasis is ours.

as a cycle, in which violence by one party causes violence by the other party and vice versa, or whether causality is unidirectional. Using data on the daily number of deaths on both sides of the conflict from September 2000 to January 2005, we find that there is little evidence to suggest that both sides of the conflict react in a regular and predictable way to violence against them. Rather, we find that the direction of causality (in the sense of Clive W. J. Granger, 1969) runs only from violence committed by Palestinians to violence committed by Israelis and not vice versa. That is, we find that the incidence and levels of Palestinian fatalities can be predicted by the past incidence and levels of Israeli fatalities, while there is little evidence that there is a direct relationship between fatal casualties suffered by the Palestinians and a lethal response. This finding is robust to the specification of the lag structure and the level of time aggregation. We find little evidence that violence on either side has a direct deterrent or incapacitation effect, nor that *intended* levels of Palestinan violence are related to past Palestinian fatalities.

There is a long tradition of economic research on conflict. Nobel laureate Thomas C. Schelling's formative work, *The Strategy of Conflict* (1960), laid the groundwork for thinking about conflict as non-zero-sum games. While Schelling's theoretical insights were most applicable to a situation in which there are two actors of roughly equal strength (e.g. the Cold War), his work on randomization and mixed strategies is directly applicable to the Palestinian-Israeli conflict. One of Schelling's main insights was that it is possible for it to be optimal, even in non-zero-sum games, for one or both sides to act in a deliberately random manner in equilibrium. Despite the central role played by mixed strategies in the games analyzed by Schelling and others in different economic contexts, there has been relatively little empirical

evidence showing that players actually choose mixed strategies in non-experimental settings.[4] The results in this paper suggest that the Palestinians may have chosen to deliberately randomize the timing of their response to Israeli violence, thus providing one of the first pieces of evidence of mixed strategies in an important real-world setting.

In recent years, a small literature has developed examining various aspects of the Palestinian-Israeli conflict, particularly terrorism. Zvi Eckstein and Daniel Tsiddon (2004) examine the effects of terrorism on macroeconomic aggregrates while Claude Berrebi and Esteban F. Klor (2005) examine its effects on financial markets. Claude Berrebi and Esteban F. Klor (2006) model the interaction between Palestinian militant groups and the Israeli political system. The individual and aggregate determinants of terrorism have been studied by Claude Berrebi (2003), Alan B. Krueger and Jitka Maleckova (2003), Alan B. Krueger and David D. Laitin (2003), and Eli Berman (2003). Our paper is more closely related to the work of Edward H. Kaplan et al. (2005), who analyze the effect of Israeli antiterrorism tactics on the recruitment of Palestinian terrorists. Asaf Zussman and Noam Zussman (2006) attempt to assess the effectiveness of Israel's policy of targeted killings of terrorist leaders in the current conflict by looking at the reaction of the Israeli stock market. Our paper contributes to this literature by looking directly at the dynamic pattern of violence in the Palestinian-Israeli conflict.

I. Data and Descriptive Statistics

To construct the data on the daily series of fatal casualties in the Palestinian-Israeli conflict since September 2000, we rely primarily on the web site of B'Tselem (*http://www.btselem.org*), an Israeli human rights organization. Widely thought to be accurate and reliable, the data

[4] Non-experimental evidence of mixed strategies is mostly limited to the analysis of sports contests (Mark Walker and John Wooders, 2001; Pierre-André Chiappori, Steven Levitt and Timothy Groseclose, 2002; Ignacio Palacios-Huerta, 2003).

published by B'Tselem record in detail every fatality (excluding suicide bombers) on both sides of the conflict during the second Intifada. They include information on the date and circumstances of the fatal wounding, the date of death, the age, gender and locality of residence of the victim, and whether the victim was a civilian or a member of the security forces. The main advantage of these data are their comprehensiveness and the symmetrical treatment of fatalities on both sides of the conflict, something that is unavailable in the official statistics compiled by either side in the conflict.

Our sample period goes from September 29, 2000 to January 15, 2005, approximately at the time when Mahmoud Abbas assumed the presidency of the Palestinian Authority. The Israeli count includes all civilians and members of the security forces killed during this period, either in Israel (within the 1948 borders) or in the Territories, as well as foreign civilians killed by Palestinians. The Palestinian count includes all civilians and members of the security forces, as well as foreign civilians killed by Israeli security forces and civilians. The total number of Palestinian fatalities, 3,244, is more than three times the number of Israeli fatalities, 994.

Figure 1 shows the monthly number of fatal casualties over our sample period. We highlight seven different phases of the conflict. The Intifada began on September 29, 2000, and the events that mark the different phases are: 1) the election of Ariel Sharon as prime minister on February 6, 2001, 2) the attacks on New York and Washington, D.C. on September 11, 2001, 3) the beginning of Operation Defensive Shield on March 29, 2002, 4) the announcement of the "Road Map" by the Bush Administration on June 25, 2002, 5) the summer 2003 ceasefire, which was announced on June 29, 2003, 6) the end of the ceasefire on August 22, 2003. We present a more detailed discussion of the chronology of the conflict in David A. Jaeger and M. Daniele Paserman (2005).

There was a large imbalance between the number of Palestinian and Israeli fatal casualties in the first phase of the conflict. The second phase, characterized by international efforts to broker a ceasefire saw a reduction in the level of violence on both sides. The level of violence rose sharply on both sides during the third phase of the conflict, after the failure of the international community's mediation efforts, and up to Operation Defensive Shield. During the fifth phase, with the reoccupation of the major population centers in the West Bank by the Israeli army, the number of Palestinian fatalities remained at a high level. The number of Israeli fatalities during this period appears to exhibit a slight downward trend, with a few substantial spikes due to major suicide bombings. The level of violence on both sides dropped to nearly zero during the summer 2003 ceasefire. As the ceasefire broke down, however, the number of Palestinian fatalities returned to its pre-ceasefire levels, while the number of Israeli fatalities continued to fall.

II. Theoretical and Empirical Framework

We contend that three main factors may induce a dynamic link between violent incidents on the two sides of the conflict. First, violence by one side can have an *incapacitation* effect, if it limits the other side's capability to react. For example, Palestinian attacks against the IDF may reduce its capacity to respond. More plausibly, perhaps, Israeli targeted killings of key Palestinian leaders might reduce Palestinians' ability to carry out further attacks against Israel; this is the stated Israeli rationale for such actions. Second, violence can have a *deterrent* effect, when one side refrains from using violence in fear of the other side's reaction. Finally, violence by one side can lead to a reaction by the other side through a *vengeance* effect, to the extent that one side wishes to dispense retribution in response to the fatal casualties it suffers.

Solving for a full dynamic and game-theoretic equilibrium of violent behavior based on these three motives is beyond the scope of this paper. Instead, we posit the existence of *empirical reaction functions* for both sides, and employ a vector autoregression (VAR) framework using the daily data from B'Tselem. Our basic specification is:

$$\begin{pmatrix} Pal_t \\ Isr_t \end{pmatrix} = \mathbf{A}_0 + \mathbf{A}_1 \begin{pmatrix} Pal_{t-1} \\ Isr_{t-1} \end{pmatrix} + \ldots + \mathbf{A}_p \begin{pmatrix} Pal_{t-p} \\ Isr_{t-p} \end{pmatrix} + \mathbf{B}\mathbf{X}_t + \boldsymbol{\varepsilon}_t ,$$

where the $\mathbf{A_j}$'s and $\mathbf{B}$ are matrices of coefficients, $\mathbf{X_t}$ is a vector of exogenous variables that may shift the reaction function up or down, and $\boldsymbol{\varepsilon}_t$ is the vector error term. Note that the dependent variable is fatalities of the *opposite* group. That is, for the Israeli reaction function the dependent variable is Palestinian fatalities, and vice versa. Our primary interest is the effect of "own" fatalities on fatalities of the opposite group. The signs of the coefficients on the "own" fatalities variables tell us whether the incapacitation and deterrence effects or the vengeance effect is dominant. We employ two different specifications of the VAR. In the first specification (the *incidence* specification), Pal_t and Isr_t are dummies for whether there were any Palestinian and Israeli fatalities on day t; in the second (the *levels* specification) Pal_t and Isr_t are the total number of fatalities in day t. All models are estimated equation by equation with ordinary least squares and heteroskedasticity-consistent standard errors. [5]

While the signs of the individual coefficients are of some interest, our primary focus is testing, overall, whether fatalities on one side of the conflict cause fatalities on the other side. That is, can we reasonably say that side A reacts to the actions of side B and vice versa? Our main empirical tool for doing so is the Granger (1969) causality test. In a vector autoregression,

[5] Estimating the model equation by equation is equivalent to assuming that the off-diagonal terms of $E(\varepsilon_t \varepsilon_t')$ are equal to zero. Estimating the system jointly yields identical inferences. We have also estimated the models using a probit specification for the incidence regressions and zero-inflated Poisson specifications for the levels regressions reported below. This yielded no qualitative difference from the results presented here.

a variable *X* is said not to Granger-cause *Y* if, conditional on lagged values of *Y*, lagged values of *X* have no predictive power for the current value of *Y*. In practice, the Granger tests amounts to a test of the joint significance of the coefficients on lagged values of *X* in a regression of *Y* on lagged values of *Y* and lagged values of *X*.

The primary issue is whether the Granger test can be given a true causal interpretation. This boils down to the standard exogeneity question: is the disturbance term in the equation for one's side fatalities correlated with past values of the opposite side's fatalities? While it is possible that there are factors that may induce a correlation between the regressors and the disturbance (e.g. an endogenous increase in Israeli preventive measures following an attack against Palestinians, an issue which we discuss at length in Section IV), it is the nature of the type of violence in this conflict that many of the realized fatalities are due to random elements. For example, did the suicide bomber enter a crowded or empty bus? Did the intended target of an assassination attempt sit in the front or the back of his car? Given these random factors, we suspect that endogeneity bias is unlikely to be quantitatively important for our results.

It is possible that Granger causation runs in the opposite direction of true causation, especially with time series that reflect forward-looking behavior.[6] Such forward-looking behavior would lead to reverse causation if the expected future level of violence on one side affected the other side's level of violence in the present. In the context of this conflict, it would be unreasonable to assume away any form of forward-looking behavior. We argue, however, that plausible forms of forward-looking behavior are likely to bias our estimates in a direction that is contrary to what we actually observe. For example, attempts by Palestinian radical groups to scuttle the peace process (Andrew Kydd and Barbara F. Walter, 2002) would lead to a finding of Palestinian violence Granger-*reducing* Israeli violence, which is the opposite of what we observe

[6] For example, stock prices Granger-cause dividends or Christmas cards Granger-cause Christmas.

in practice. Similarly, if Israelis pre-emptively struck the Palestinians in anticipation of future Palestinan violence, we would be biased towards finding evidence of Israeli violence Granger-causing a Palestinian response, which is also in contrast to what we actually observe. The potential for mistakenly interpreting Granger causation as true causation would exist if, for example, the Palestinians engaged in pre-emptive strikes in anticipation of an Israeli attack (leading us to find that Palestinian violence Granger-causes Israeli violence). Because of the large imbalance in the military and intelligence capabilities of the two sides, this scenario seems, to us, fairly implausible. Thus, we view the potential for our results to be a product of reverse causation to be very small indeed.

III. Results

Before estimating the regressions defined above, we first present nonparametric impulse response functions for both sides. We define the empirical Israeli and Palestinian response functions, respectively, as

$$IsrRF_t = \frac{\sum_{s:I_{s-t}>0} P_s}{\sum_{s:I_{s-t}>0} 1} - \frac{1}{T}\sum_s P_s \text{ , and}$$

$$PalRF_t = \frac{\sum_{s:P_{s-t}>0} I_s}{\sum_{s:P_{s-t}>0} 1} - \frac{1}{T}\sum_s I_s \text{ ,}$$

where P_s and I_s are the number of Palestinian and Israeli fatalities on day s. In words, the Israeli empirical response function at time t is the average number of Palestinian fatalities exactly t days after a day in which there was at least one Israeli fatality, minus the unconditional mean of

Palestinian fatalities over the entire period. The empirical Palestinian impulse response function is defined similarly.

We present the empirical impulse response functions with 95 percent confidence bands in Figures 2a and 2b for the Israelis and Palestinians, respectively. The contrast between the two response functions is striking. The Israeli response function shows that the number of Palestinian fatalities is above the mean for the first 38 days after a day with Israeli fatalities and that this difference is statistically significant for the first 10 of those days. The Palestinian response is never statistically significant, although it is positive for 26 out of the first 31 days. The magnitude of the Israeli response, on average, is about 17 times larger than the Palestinian response for the first 10 lags and about 15 times larger for all 60 lags shown in the figures.

In Table 1 we present the coefficients of the Israeli and Palestinian reaction functions, estimated from a VAR model with fourteen lags. We control for the day of the week and the seven periods of the conflict described earlier. We also control for the cumulative length of the separation barrier dividing the West Bank from Israel.[7]

Columns 1 and 2 of Table 1 present the Israeli reaction function using the incidence and the number of Palestinian fatalities as the dependent variable, respectively. We are primarily interested in the coefficients on lagged Israeli fatalities, which are boxed. Both the incidence and levels specification indicate that Israel reacts in a statistically significant and regular way after fatal Palestinian attacks. Overwhelmingly, the coefficients are positive, and many of them are statistically different from zero. The lack of any negative and statistically significant coefficients suggests that Palestinian attacks do not have a net deterrent or incapacitation effect. The period

[7] This variable was constructed using detailed data on the dates of completed construction and the length of each segment of the separation barrier, provided by the Israeli Ministry of Defense. We have estimated all the models without the control variables, and the results are essentially identical (David A. Jaeger and M. Daniele Paserman, 2005).

dummies generally reflect the pattern of Israeli violence against Palestinians shown in Figure 1. While the pattern of reaction is of some interest, our primary focus is on the test of Granger causality, reported in the penultimate line of the table. We find clear evidence that fatal Palestinian attacks Granger-cause an Israeli response leading to the death of Palestinians.

We present estimates of the Palestinian reaction function in columns 3 (incidence) and 4 (levels). While we find some degree of serial correlation in the Palestinians' attacks on Israelis, we find no support for the hypothesis that Israel's actions cause a Palestinian response: the *p*-values in the Granger tests are well above conventional significance levels, and the coefficients on lagged Palestinian fatalities, boxed in the table, are generally small and not statistically significant. That we estimate no negative and significant coefficients indicates that Israeli attacks against Palestinians do not have a net short-term deterrent or incapacitation effect. We also find that the separation barrier has little effect on the probability and magnitude of deadly Palestinian attacks against Israelis.[8] We are cautious about interpreting this finding as conclusive regarding the effectiveness of the barrier, however, as the barrier may be effective only when it is complete. More geographic detail on the location of the barrier and of Israeli fatalities might also affect our conclusions.

Overall, we find there is strong evidence that the Israelis react in a significant and predictable way to Palestinian violence against them, but there is no evidence that the Palestinians react to Israeli violence. This stands in contrast to the popular notion that the Israelis and Palestinians are engaged in a "tit-for-tat" cycle of violence.

Previous research (James H. Stock and Mark W. Watson, 1989) has shown that conclusions about Granger causality may be sensitive to the choice of the lag structure for the

[8] The coefficient on the separation barrier is negative and statistically significant in both the incidence and levels regression when we do not include the period dummy variables.

independent variables as well as the lagged values of the dependent variable. To examine this issue, we estimated the incidence and levels regressions that include the day-of-week and period indicators as well as the length of the separation barrier for a variety of combinations of 4, 7, 14, and 21-day lag structures. We present the χ^2 statistics for the tests of Granger causality in these models in Table 2. We find no evidence that our conclusions regarding the lack of a Palestinian response to Israeli violence is sensitive to the choice of lag structure. We continue to find that Palestinian violence Granger-causes an Israeli response in all of the incidence specifications and in the levels specifications with 14 lags or fewer. Although we cannot reject the null hypothesis of no Granger causality in the specifications with 21 lags, it is well known that adding lags can reduce the power of the Granger test.[9]

Using daily data may mask some broader features of the reaction functions, particularly for the Palestinians, and our results could be sensitive to the frequency at which we aggregate fatalities. The decentralized and factional nature of the Palestinian side may dictate longer or less regular response times that may not be captured at a daily frequency. To explore this possibility, in Table 3 we present Granger causality statistics from the Israeli and Palestinian reaction functions estimated at weekly, bi-weekly, and monthly frequencies. Because there is very little variation in incidence at these frequencies, we present only results for regressions using levels. We do not find a significant response by the Palestinians at any frequency, lending weight to our finding that Israeli violence does not Granger-cause a Palestinian response. Using weekly data, we continue to find that Palestinian violence Granger-causes an Israeli response using models with both two weeks and four weeks of lags, although the model with two lags is only significant at the 10.1 percent level. While not shown in the table, the coefficient on the first week's lag is always substantially larger than the coefficient on the other week(s). At the bi-

[9] In these specifications the first 14 lags are always jointly significantly different from zero.

weekly frequency, we do not find a significant Israeli response, while we do find a significant response at the monthly frequency. [10]

IV. Israeli Preventive Measures

We have consistently found that Palestinian violence cannot be predicted by past Israeli violence. One potential explanation for this finding is that the Palestinians do try to react, but are unable to do so effectively because of Israeli countermeasures. For example, it is possible that Israel, anticipating a Palestinian reaction, steps up its preventive measures to thwart any possible Palestinian response. These can take the form of more frequent roadblocks, tighter restrictions on the movement of Palestinians within the Occupied Territories and from the Territories into Israel, increased presence and alertness of the Israeli security forces in crowded areas, as well as arrests of suspected Palestinian militants. This scenario would imply that an important explanatory variable is omitted from the equation specifying Palestinian violence. To counter this concern, we take two approaches. We first construct a measure of Israeli vigilance based on data on restrictions to movement of Palestinian civilians through Israeli checkpoints in the Occupied Territories, and examine whether the inclusion of this measure in the regressions affects the estimates of the Palestinian reaction function. We then look directly at whether the intended level of Palestinians violence is affected by past Israeli actions, using data on prevented terror attacks and terror warnings collected by the IDF.

Restrictions to Movement

[10] Our results are not sensitive to disaggregation by civilian status, by location or by time period. We have also examined the dynamics between assassination attempts by Israel and suicide attacks by the Palestinians. In general the results are comparable to those presented here. See Jaeger and Paserman (2005).

The United Nations Office for Coordination of Humanitarian Affairs (OCHA) has compiled a series of verbal reports on restrictions to movement of Palestinians within the Occupied Territories and between the Occupied Territories and Israel. The OCHA website records, on a daily basis, whether there were any restrictions to the movement of Palestinians at each of 88 checkpoints in the West Bank and Gaza. We hand-coded the data, assigning to each checkpoint a value ranging from 1 (completely closed) to 5 (completely open).[11] The data is available from October 1, 2003 to the end of our sample period. We excluded checkpoints that appear in the OCHA reports for a total of less than 365 days, leaving a total of 45 checkpoints in our sample.[12] We then calculated for each day the fraction of checkpoints that were completely closed, and used that as our measure of Israeli vigilance. We note that often a checkpoint was completely closed because of a "hot" security warning, leading us to believe that the measure we use is indeed a good proxy for Israeli vigilance and for the level of Palestinian violence anticipated by the Israeli security forces. The average percentage of checkpoints that were completely closed was 15.6 percent, with a standard deviation of 5.6 percent.

In Table 4, we present regressions of the fraction of checkpoints closed on lagged Palestinian and Israel fatalities.[13] To preserve the largest number of observations possible, while also providing a parsimonious specification that captures the essential features of the data, we use as regressors the *sum* (over days t-1 to t-7 and t-8 to t-14) of the lagged values of the fatality variables. We find that checkpoint closings are positively associated with lagged Palestinian fatalities, meaning that Israel does impose tighter restrictions to the movement of Palestinians

[11] In the Appendix we give some examples of how we transformed the verbal descriptions in the OCHA reports into a numeric scale.

[12] These are presumably the most important checkpoints in the Occupied Territories. Our results are not sensitive to using all 88 checkpoints, or only checkpoints in the West Bank, or only checkpoints on the border between the Territories and Israel.

[13] The results for the association of border closings and lagged incidence of Israeli and Palestinian fatalities are qualitatively similar and are available from the authors by request.

after it has inflicted a high number of Palestinian fatalities. This suggests that our constructed measure of border closings is a reasonable proxy for Israeli vigilance. Interestingly, we also find that lagged Israeli fatalities are strongly positively associated with closings, suggesting that to some extent Israel uses closings as a retaliatory measure against Palestinian violence.

In Table 5, we assess whether controlling for Israeli preventive measures affects the estimates of the Palestinian reaction function. The top panel presents the incidence specification: to make the results more easily interpretable, we use the number of days from *t*-1 to *t*-7 and from *t*-8 to *t*-14 with Palestinian and Israeli fatalities as the right hand side regressors. The bottom panel presents the levels specification with the total number of Palestinian and Israeli fatalities in days *t*-1 to *t*-7 and in *t*-8 to *t*-14 as regressors. Column 1 reproduces the estimates of the Palestinian reaction functions from Table 1 with this parsimonious specification, with essentially identical results.

Column 2 presents the estimates of these same specifications, for the period from 1 October 2003 to 15 January 2005, where we have data on checkpoint closings. None of the coefficients on lagged Palestinian fatalities is individually or jointly statistically significant in either the incidence or levels regressions. In column 3 we add the closure variable to these regressions. In the incidence regressions we find that the closure variable is not statistically significant while in the levels regression it is, with more border closings somewhat surprisingly leading to more Israeli fatalities.[14] Our conclusion regarding the lack of Granger causality is not altered in any way, however, in either specification. While our border closing variable may not be a perfect measure of Israeli vigilance, we suspect that any potential endogeneity bias in our

[14] This finding reinforces the notion that border closings may be a proxy for anticipated Palestinian violence, some of which is eventually realized.

results is quite small – and cannot account for the lack of an estimated Palestinian response to Israeli violence in our general specifications.

Intended Palestinian Violence

To this point, all of our analysis has been based on realized levels of violence, measured by fatalities. Our focus on realized violence may miss many non-lethal activities by the Palestinians and induce considerable bias into our estimates of the reaction functions. This may remove the appearance of tit-for-tat actions by the Palestinians when they are, in fact, following that strategy.

Numerous attempted Palestinian attacks have been thwarted by IDF intelligence operations, which have led to arrests of terror suspects and *en route* interceptions of suicide bombers. The IDF has collected data on the total number of successful and of unsuccessful attacks from the beginning of the Intifada until the end of 2004.[15] Unsuccessful attacks include those that were either thwarted by a preventive action by the IDF or the General Security Service, or were not carried out because of "work accidents" or other failures in the execution of the attack.

We use these data to estimate a series of Palestinian reaction functions. These estimates are presented in columns 1 through 3 of Table 6, with dependent variables being the total number of Palestinian attacks, the number of prevented attacks, and the number of successful attacks, respectively. Because the data are measured only at a monthly frequency, we have 51 observations, and therefore include as regressors only one lag of Palestinian and Israeli fatalities as well as our period indicators and the completed length of the separation barrier variable. In the

[15] These data are publicly available on a *monthly* frequency from the IDF web site. Unfortunately, higher frequency data on successful and unsuccessful attacks is not made available to the public for security reasons, preventing us from analyzing whether the intended level of Palestinian violence responds to Israeli violence in the short run.

first column, we find no correlation between the total level of intended Palestinian violence (both successful and unsuccessful) and the lagged number of Palestinian fatalities. We also find no quantitatively or statistically significant relationship between the number of prevented attacks and past Israeli violence, in column 2. In the third column we simply reproduce the results on realized violence presented previously, this time using the IDF count of successful attacks instead of the B'Tselem data. Whether measured using successful (fatal) attacks, unsuccessful attacks, or total attacks, we continue to find no effect of lagged Palestinian fatalities on the level of Palestinian violence.

In the last column of Table 6, we use as the proxy for intended violence the monthly average of terror warnings per day received by Israel's security forces, available for 2004 and 2005. Terror warnings can take many forms, ranging from a detailed notification of a terrorist operation to take place at a specific time and place, to a more general warning about the intentions of militant groups to carry out attacks.[16] Again, we find no evidence that the overall number of Palestinian fatalities raises the number of terror warnings. Indeed, the coefficient in column 4 is small in magnitude and negative. We are hesitant to place too much weight on these results, however, because of the small number of observations (24), and because they encompass the period of "declared calm" announced by Hamas after the election of Mahmoud Abbas in January 2005.[17] It is nevertheless striking that there is no hint of a positive correlation between lagged Israeli violence and the number of terror warnings.

While of course we are cautious about placing too much emphasis on results based on regressions with so few observations, the estimates in Table 6 confirm the results of our previous

[16] Data on the number of terror warnings is available from the Israeli Prime Minister's web site, under the heading of GSS announcements: *http://www.pm.gov.il/PMOEng/Communication/Spokesman/gss/gss060105.htm* (for 2004), and *http://www.pm.gov.il/PMOEng/Communication/Spokesman/gss/spoketer020106.htm* (for 2005).
[17] In 2005, the number of fatalities dropped roughly by a factor of 4, for both Israelis and Palestinians.

analysis. The preponderance of evidence suggests that the Palestinians do not respond in a systematic way to Israeli violence, regardless of whether the Palestinians' response is measured by realized fatalities or by intended violence.

V. Discussion

What accounts for the differences in the estimated reaction functions of Israelis and Palestinians? Both sides probably would like to react to violence by the opposite side, to satisfy a vengeance motive and to signal to the other side that violence is costly. There is obviously a marked asymmetry between the two sides, however, in terms of their decision making processes and the technology at their disposal. The IDF is highly organized and centrally commanded, meaning that Israel has the organizational, logistic and technological capabilities to inflict fatalities on the Palestinian side when it wishes. This can explain our finding that Israel reacts predictably to Palestinian violence, even though in most of our specifications we find no evidence of a short-term net deterrent effect of Israeli actions. It seems possible that Israeli actions did have a deterrent effect in the long run – the overall level of Palestinian violence has declined since peaking in 2002, partially because of self-imposed ceasefires declared by the Palestinian factions.

In contrast, it appears that Palestinian violence is difficult to predict with past Israeli actions. Part of this can probably be attributed to the technology available – the Palestinians have limited means, and carrying out attacks against Israel may require long planning and complex logistics. In addition, the ability of the Palestinians to respond in an organized, timely, and predictable way is hampered by the decentralized nature of the various groups (Hamas, Islamic Jihad, al Aqsa Martyr Brigades, etc.) who engage in attacks against Israelis.

It is also possible that the Palestinians choose to act in a deliberately unpredictable way. Given Israel's intelligence capabilities and the various measures it can adopt to prevent Palestinian attacks, it is likely that a systematic Palestinian response could be easily thwarted. Therefore, it is probably optimal for the Palestinians to randomize the timing of their response, if they wish to increase the likelihood of inflicting costs on Israel. The effectiveness of terror attacks (and suicide attacks in particular, which account for a substantial fraction of Israeli fatalities) in disrupting day-to-day Israeli life, is, almost by definition, greater if these attacks are to some extent unpredictable. Moreover, as Schelling (1960, Chapter 8) noted, it may be optimal for one side in a conflict to act randomly (i.e. in a manner that is out of its control) until certain demands are met. Given our evidence, it seems possible that Fatah and Yasser Arafat followed this strategy as they did relatively little to rein in Hamas and Palestinian Islamic Jihad – these groups were essentially acting randomly and out of his control.

We must also consider the possibility that the Palestinians, who view the current *status quo* as severely oppressive, are motivated by factors other than revenge, deterrence, and incapacitation, and that resistance to the military occupation itself is the driving force behind Palestinian violence. One of the Palestinians' stated goals has been the withdrawal of Israelis from the Gaza Strip and the West Bank. Short-term and predictable responses to Israeli violence may not be necessary or even desirable in achieving these ends. Seen in this light, the recent withdrawal of Israeli settlements in Gaza might be viewed as a long-term outcome of violence against Israelis.

Finally, it is possible to quantify the overall, long-term effect of violence by one side on the other side's reaction. To do so, we calculate the simple impulse-response function implied by the regressions in levels presented in Table 1, and then compute the cumulative number of

fatalities on one side of the conflict due to one fatality on the opposite side.[18] At 60 days after a fatality, each of the cumulative impulse response functions reaches a nearly steady state. We find that one Palestinian fatality raises the cumulative number of Israeli fatalities by 0.25 in the long run. In contrast, one Israeli fatality raises the number of Palestinian fatalities by 2.19, nearly a factor of ten greater than those caused by a Palestinian fatality.[19] Moreover, while the cumulative number of Palestinian fatalities is statistically different from zero at every horizon, we cannot reject the null hypothesis that Palestinian fatalities inflicted by Israel have no effect on the cumulative level of violence. The ninety-five percent confidence band of the Palestinian reaction function indicates that one Palestinian fatality would induce at most 0.53 Israeli fatalities in the long run. Overall, there is little evidence in the data to suggest that the conflict can be characterized as a self-perpetuating cycle of violence.

V. Conclusion

Our results paint a consistent picture of the dynamics of violence between Israelis and Palestinians during the Second Intifada. We find strong evidence that Israel reacts in a predictable and significant way to fatal Palestinian attacks against Israelis, both in terms of the incidence and magnitude of subsequent Palestinian fatalities. The result is robust to the lag structure used and to the level of time aggregation. There is little evidence to suggest that the Palestinians have a similar response to Israeli violence. We repeatedly find no significant

[18] The simple impulse response function assumes that, in the vector moving average (VMA) representation of the system of equations, there is no immediate (contemporaneous) response by any of the two sides to an exogenous shock to violence by the opposite side. Given that we are using daily data, we view this assumption as reasonable. We have also calculated an orthogonalized impulse response function that assumes that Israel may respond simultaneously to Palestinian violence, but not vice versa, and the results are essentially unchanged.

[19] The ten to one ratio is relatively invariant to the number of lags used in the regressions to generate the impulse response functions.

relationship (either positive or negative) between Palestinian fatalities and the Palestinian response; this finding is not at all sensitive to the lag structure or frequency of data used.

We conclude that, despite the popular perception that Palestinians and Israelis are engaged in "tit-for-tat" violence, there is no evidence to support that notion. Rather, the Israelis react in a predictable and statistically significant way to Palestinian violence against them while Palestinian actions appear not to be related to Israeli violence, either through revenge or deterrence. Our results suggest that a cessation of Palestinian violence against Israel may eventually lead to an overall reduction in the level of violence. The dramatic drop in the number of fatalities on both sides in 2005, after Hamas unilaterally declared a protracted "period of calm", lends support to this conclusion.

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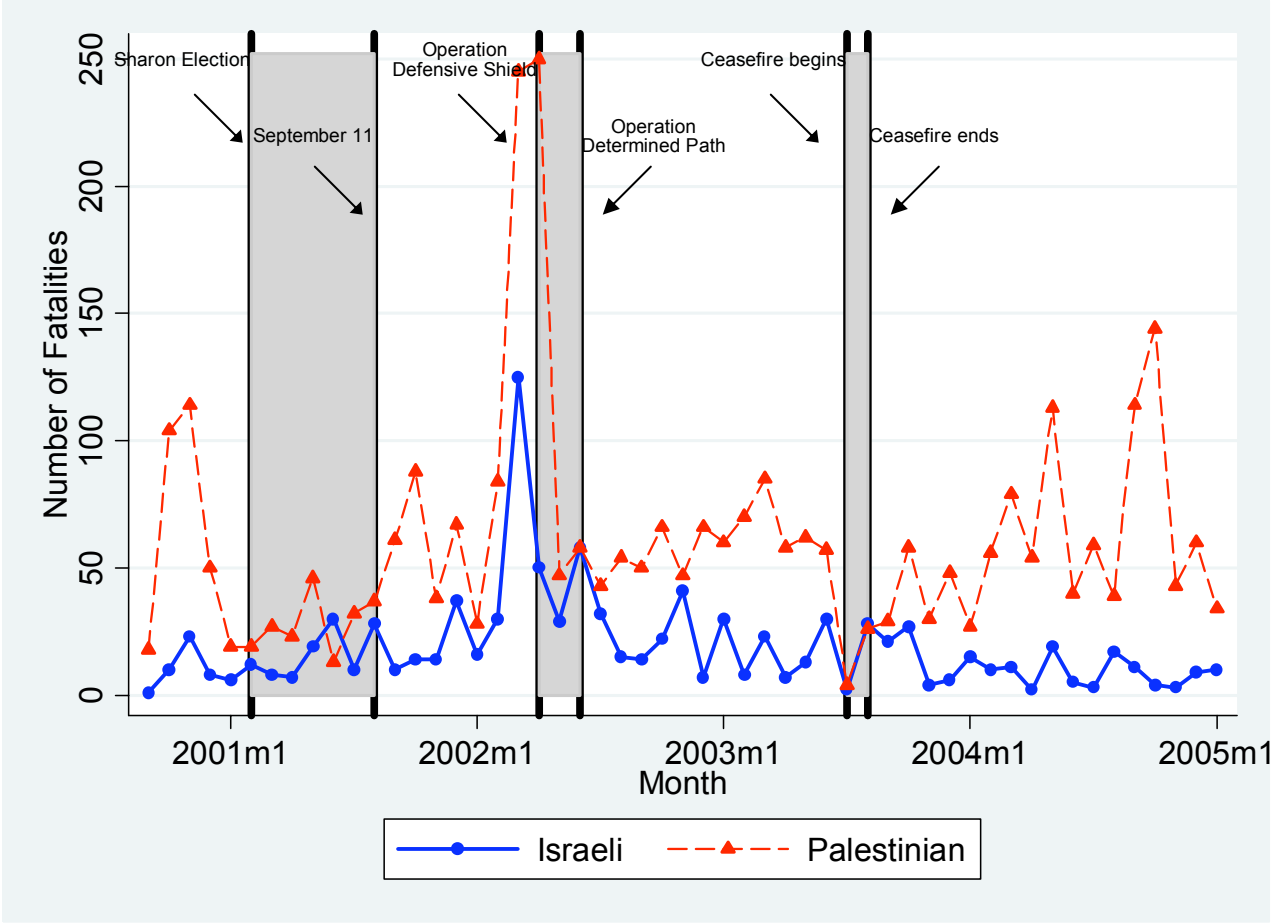
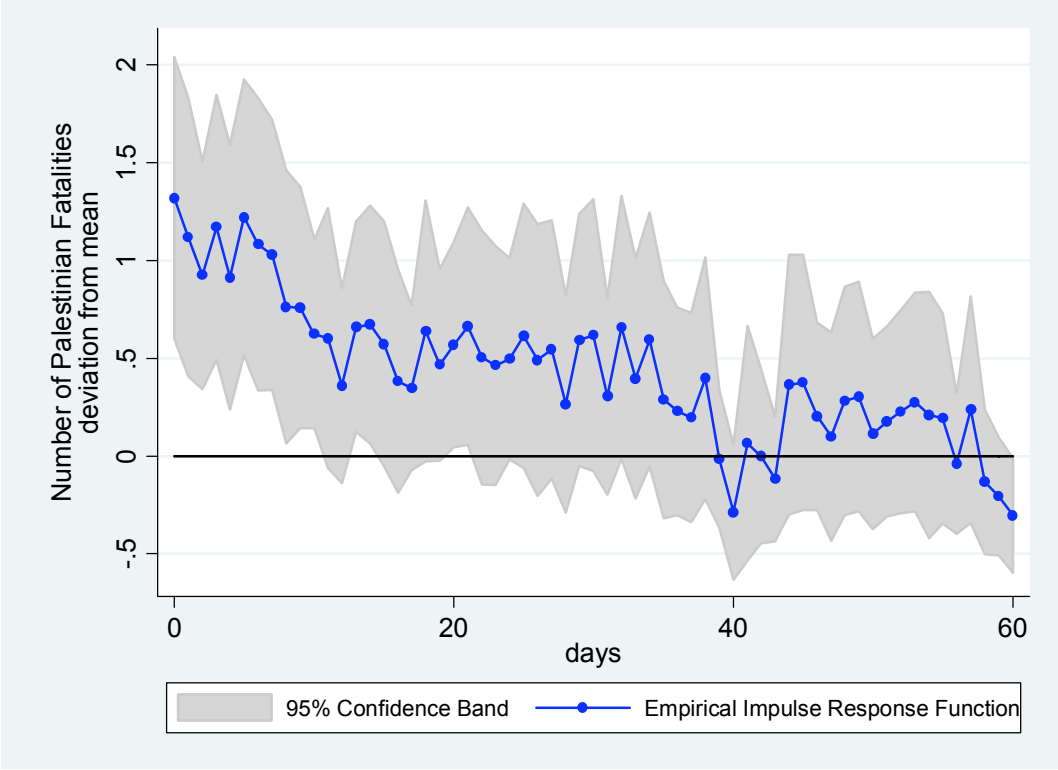
Figure 1: Monthly Number of Fatalities



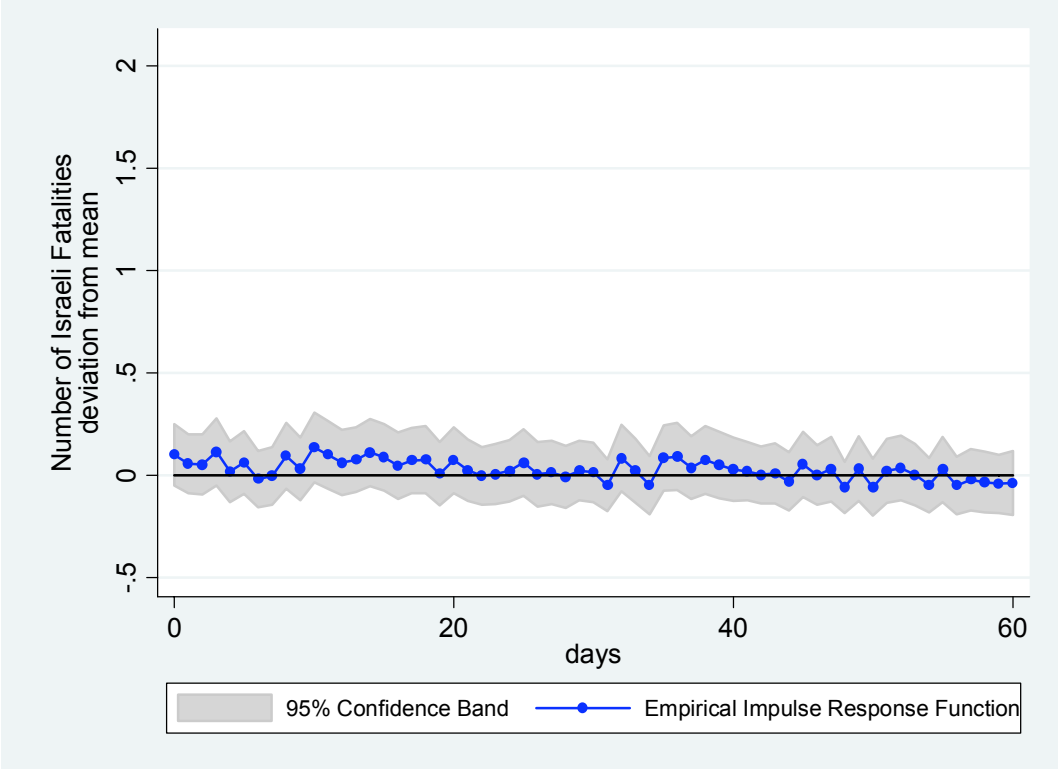
Source: Authors' calculations from B'Tselem data, from 29 September 2000 to 15 January 2005.

Figure 2a: Empirical Israeli Response Function



Source: Authors' calculations from B'Tselem data, from 29 September 2000 to 15 January 2005.

Figure 2b: Empirical Palestinian Response Function



Source: Authors' calculations from B'Tselem data, from 29 September 2000 to 15 January 2005.

Table 1
Daily Reaction Functions, Incidence and Number of Fatalities

	Israeli Reaction Function				Palestinian Reaction Function			
	(1) Incidence		(2) Number		(3) Incidence		(4) Number	
	Coef.	*z*	Coef.	*z*	Coef.	*z*	Coef.	*z*
Israeli Fatalities								
t-1	.071	2.36	0.128	1.94	.055	2.00	0.072	2.18
t-2	-.001	-0.04	0.066	1.29	.046	1.71	-0.012	-0.59
t-3	.044	1.44	0.096	2.11	.014	0.54	0.008	0.39
t-4	.060	1.99	0.051	0.75	.009	0.35	0.026	0.60
t-5	.078	2.58	0.223	1.73	.047	1.66	-0.013	-0.80
t-6	-.010	-0.33	0.050	1.12	.026	0.96	-0.021	-0.79
t-7	.014	0.45	0.054	1.18	.030	1.06	-0.013	-0.46
t-8	.047	1.53	0.138	1.03	.015	0.57	-0.024	-1.51
t-9	.072	2.40	-0.023	-0.49	-.015	-0.56	-0.006	-0.25
t-10	.054	1.79	0.049	1.32	.058	2.09	0.010	0.40
t-11	.031	1.00	-0.070	-1.65	.019	0.73	-0.001	-0.05
t-12	-.004	-0.13	0.002	0.05	.022	0.83	-0.007	-0.41
t-13	.008	0.25	0.024	0.65	-.000	-0.01	0.046	1.04
t-14	.006	0.18	0.008	0.24	.025	0.91	0.002	0.06
Palestinian Fatalities								
t-1	.026	0.98	0.164	3.31	-.009	-0.42	0.026	1.33
t-2	.045	1.72	0.100	3.21	.022	1.06	0.027	1.08
t-3	-.041	-1.58	0.140	1.27	.006	0.28	0.000	0.01
t-4	.039	1.49	0.020	0.41	-.023	-1.10	-0.009	-0.55
t-5	.045	1.70	0.043	1.25	.031	1.49	0.014	0.47
t-6	.026	0.96	-0.005	-0.13	-.027	-1.28	-0.011	-0.54
t-7	-.022	-0.85	0.009	0.26	-.020	-0.98	-0.029	-1.81
t-8	-.007	-0.28	-0.024	-0.73	.012	0.56	0.064	2.73
t-9	.034	1.31	-0.050	-1.65	-.009	-0.41	0.005	0.24
t-10	.022	0.84	-0.019	-0.73	.004	0.21	0.009	0.44
t-11	-.004	-0.14	0.035	1.51	.008	0.41	0.012	0.69
t-12	.038	1.48	0.011	0.37	-.014	-0.69	-0.026	-1.96
t-13	-.006	-0.24	-0.027	-1.14	.006	0.28	-0.020	-1.14
t-14	-.020	-0.78	0.001	0.05	.016	0.79	0.027	1.13
Periods								
Barak-Sharon	ref.		ref.		ref.		ref.	
Sharon-9/11	-.151	-2.75	-0.964	-3.35	-.021	-0.43	0.256	1.48
9/12-ODS	-.034	-0.65	-0.162	-0.46	.053	1.07	0.617	2.92
ODS-Roadmap	.066	1.12	-0.156	-0.27	.053	0.83	1.168	2.68
Roadmap-Ceasefire	-.001	-0.03	-0.586	-1.97	-.042	-0.97	0.333	1.96
Ceasefire	-.437	-4.21	-2.406	-4.23	-.155	-1.77	0.619	1.19
Post-Ceasefire	-.063	-0.42	-2.741	-2.91	-.187	-1.67	1.390	1.32
Length of Separation Barrier (10 km)	.042	0.51	1.500	2.76	.058	0.94	-0.803	-1.38
Constant	.397	5.67	0.587	1.62	.092	1.56	-0.082	-0.51
χ^2 for joint sig. of own fatalities (*p*-value)	43.50 (<.001)		24.30 (.042)		7.80 (.899)		17.50 (.230)	
R^2	.102		.233		.074		.064	

Note: Dependent variable is an indicator for any Palestinian fatalities in column 1; the number of Palestinian fatalities in column 2; any Israeli fatalities in column 3; and the number of Israeli fatalities in column 4. The right hand side variables are indicators for whether there were any Palestinian/Israeli fatalities in days *t*-1 to *t*-14 (columns 1 and 3), and counts of Palestinian/Israeli fatalities in days *t*-1 to *t*-14 (columns 2 and 4). All regressions also include day-of-week indicator variables. Heteroskedasticity-consistent standard errors.
Source: Authors' tabulations of daily data from B'Tselem from 29 September 2000 to 15 January 2005.

Table 2
Granger Causality Tests for Different Lag Structures
(χ^2 statistics, *p*-values in parentheses)

Lag Structure	Israeli Reaction Function		Palestinian Reaction Function	
(own, opposite)	Incidence	Number	Incidence	Number
(4,4)	19.69	9.95	2.77	3.04
	(.001)	(.041)	(.598)	(.552)
(7,4)	29.34	15.32	7.62	3.67
	(<.001)	(.032)	(.367)	(.817)
(14,4)	53.15	23.22	9.77	17.54
	(<.001)	(.057)	(.779)	(.229)
(21,4)	73.58	27.92	16.58	20.40
	(<.001)	(.142)	(.680)	(.496)
(7,7)	27.21	15.32	6.54	4.91
	(<.001)	(.032)	(.478)	(.670)
(14,7)	47.21	23.62	8.54	18.29
	(<.001)	(.051)	(.859)	(.194)
(21,7)	66.07	27.57	15.68	21.01
	(<.001)	(.153)	(.736)	(.459)
(14,14)	43.50	24.30	7.80	17.50
	(<.001)	(.042)	(.899)	(.230)
(21,14)	58.72	27.69	14.43	20.98
	(<.001)	(.149)	(.808)	(.460)
(21,21)	57.38	26.16	14.48	20.56
	(<.001)	(.200)	(.805)	(.486)

Note: The entries in the table are the test statistics and *p*-values for the joint hypothesis that all lags of own fatalities are equal to zero. All models include period and day-of-week indicators as well as the length of separation barrier as regressors.
Source: Authors' tabulations of daily data from B'Tselem from 29 September 2000 to 15 January 2005.

Table 3
Effect of Time Aggregation on
Granger Causality Tests: Number of Fatalities
(χ^2 statistics, *p*-values in parentheses)

Frequency of Data	Israeli Reaction Func.	Palestinian Reaction Func.
Weekly		
2 Lags	4.58	2.48
	(.101)	(.289)
4 Lags	9.19	2.74
	(.056)	(.602)
Bi-Weekly		
1 Lag	0.04	1.42
	(.838)	(.492)
2 Lags	1.96	3.10
	(.162)	(.212)
Monthly		
1 Lag	3.83	1.04
	(.050)	(.309)

Note: The entries in the table are the test statistics and *p*-values for the joint hypothesis that all lags of own fatalities are equal to zero. All models include period and day-of-week indicators as well as the length of separation barrier as regressors.
Source: Authors' tabulations of data from B'Tselem from 29 September 2000 to 15 January 2005.

Table 4
The Relationship between Border Closings and Fatalities

	Coef.	*z*
Number of Palestinian fatalities in days:		
t-1 to *t*-7	.00045	2.93
t-8 to *t*-14	.00088	4.80
Number of Israeli fatalities in days:		
t-1 to *t*-7	.00385	5.69
t-8 to *t*-14	.00417	5.91
χ^2 for joint sig. of Palestinian fatalities (*p*-value)	39.07 (<.001)	
χ^2 for joint sig. of Israeli fatalities (*p*-value)	57.65 (<.001)	
R^2	.251	

Note: Dependent variable is fraction of checkpoints closed. Estimated with ordinary least squares and includes day-of-week indicators as well as the length of the separation barrier as regressors. Heteroskedasticity-consistent standard errors.
Source: Authors' tabulations of daily data from B'Tselem from 1 October 2003 to 15 January 2005.

Table 5
The Effect of Border Closings on the Palestinian Reaction Function

	Time Period					
	(1) 29 Sep. 2000 - 15 Jan. 2005		(2) 1 Oct. 2003 - 15 Jan. 2005		(3) 1 Oct. 2003 - 15 Jan. 2005	
	Coef.	***z***	**Coef.**	***z***	**Coef.**	***z***
Dependent Variable: Incidence of Israeli Fatalities						
Number of days with Palestinian fatalities in days:						
t-1 to *t*-7	-.003	-0.36	.012	1.06	.010	0.90
t-8 to *t*-14	.003	0.37	.015	1.28	.014	1.21
Fraction checkpoints closed	-		-		.374	1.33
χ^2 for joint sig. of Palestinian fatalities (*p*-value)	0.25 (.881)		2.78 (.249)		2.25 (.325)	
R^2	.064		.025		.029	
Dependent Variable: Number of Israeli Fatalities						
Number of Palestinian fatalities in days:						
t-1 to *t*-7	0.004	0.80	0.001	0.17	-0.001	-0.15
t-8 to *t*-14	0.006	1.33	-0.002	-0.77	-0.005	-1.50
Fraction checkpoints closed	-		-		2.946	2.69
χ^2 for joint sig. of Palestinian fatalities (*p*-value)	2.56 (.278)		0.68 (.713)		3.08 (.214)	
R^2	.041		.021		.029	

Note: All models estimated with ordinary least squares and include day-of-week and period indicators as well as the length of the separation barrier as regressors. Heteroskedasticity-consistent standard errors.
Source: Authors' tabulations of daily data from B'Tselem.

Table 6
The Effect of Palestinian Fatalities on Palestinian Intended and Realized Violence
(*z*-ratios in parentheses)

Dependent variable:	**(1) Total Palestinian attacks**	**(2) Prevented attacks**	**(3) Successful (fatal) attacks**	**(4) Terror warnings**
Time period:	**Oct 2000-Dec 2004**	**Oct 2000-Dec 2004**	**Oct 2000-Dec 2004**	**Jan 2004-Dec 2005**
Number of Palestinian fatalities in month *t*-1	.005	.002	.003	-.057
	(0.31)	(0.16)	(0.44)	(-2.03)
R^2	.618	.736	.471	.043
N	51	51	51	24

Note: All models estimated with ordinary least squares and include lagged Israeli fatalities and period indicators as well as the length of the separation barrier as regressors. Heteroskedasticity-consistent standard errors.
Source: Authors' tabulations of monthly data from B'Tselem and the Israeli Defense Force.

Appendix: Numeric Codes for Checkpoint Status

The verbal reports of OCHA were transformed into a numeric scale as follows:

1- Checkpoint closed
2- Open only for permit holders, Palestinians with Jerusalem ID, international citizens, UN representatives, etc.
3- Open only for residents of some villages, cities or for workers and traders with permits.
4- Open, but there is some restriction on age, hours of opening, or there are searches and long delays.
5- Open without restrictions.

The following table gives some examples of how the verbal reports were transformed into a numeric scale for one specific checkpoint on selected dates.

Checkpoint	Date	Description	Code
Beit Jala DCO Entrance to Beit Jala, Bethlehem District	20-26 October 2004	Open from 7am to 7pm for all traffic. Palestinian public and private vehicles are allowed to pass. Buses of Hebron national bus company and commercial trucks are not allowed to cross: the buses drop off passengers at the Al Khadr - Husan junction. On 25 and 26 October, it was open for 24 hours due to the closure of Gilo checkpoint. Delays were experienced for vehicles going out of Bethlehem.	5 on October 25 and 26 4 on all other days.
Beit Jala DCO Entrance to Beit Jala, Bethlehem District	4-10 August 2004	Open 7am to 7pm for all traffic. Palestinian public and private vehicles are allowed to pass. Only buses of Hebron national bus company are not allowed to cross. Long queues and delays were experienced for the vehicles coming out of Bethlehem.	4 on all days.
Beit Jala DCO Entrance to Beit Jala, Bethlehem District	28 July 2004 – August 3 2004	Open from 07:00 – 19:00 for all traffic. Palestinian public and private vehicles are allowed to pass. Only buses of Hebron national bus company are not allowed to cross. Long queues and delays were experienced for the vehicles coming out of Bethlehem. On 2 August it was closed due to hot security warnings.	1 on 2 August, 4 on all other days
Beit Jala DCO Entrance to Beit Jala, Bethlehem District	9-15 June 2004	On 13 June the checkpoint was opened for all traffic, after being closed since 3 March 2004**.** Palestinian vehicles need permits to cross. Buses of Hebron national bus company are not allowed to cross.	1 on 9-12 June 3 on 13-15 June
Beit Jala DCO Entrance to Beit Jala, Bethlehem District	22 February 2004 – 16 March 2004	Reopened on 25 February following complete closure after 22 Feb. Closing time at 19:00 hindering ability of medical services to carry out emergency assistance in all villages to the west of Bethlehem after this time. Closed since 03 March.	1 on 22-24 February 4 on 25 February - March 2 1 on March 3- March 16
Beit Jala DCO Entrance to Beit Jala, Bethlehem District	3-9 December 2003	Open 7:00 to 19:00 hours to internationals and Palestinians with permits.	2 on all days.

Prof. David A. Jaeger is currently an Associate Professor of Economics and Public Policy at the College of William and Mary in Williamsburg, VA, and a Visiting Research Fellow at the Institute for the Study of Labor (IZA) in Bonn, Germany. He has held regular and visiting positions at the U.S. Bureau of Labor Statistics in Washington, DC, Hunter College and the Graduate Center of the City University of and Princeton University. His research focuses on immigration and migration, education, and applied econometrics, in addition to the Palestinian-Israeli conflict. His work has been published in the American Economic Review, the Review of Economics and Statistics, the Journal of Labor Economics, and the Journal of the American Statistical Association, among others.

Dr. M. Daniele Paserman is currently a Lecturer in the Department of Economics at the Hebrew University of Jerusalem, and, starting in August 2007, an Associate Professor at Boston University. His research spans a number of areas in labor economics and applied microeconomics: immigration and its effects on the host country's educational system and its labor markets; models of search, with applications to job markets and marriage markets; discrimination in the labor market; and a number of issues related to the dynamics of violence and the political economy of the Palestinian-Israeli conflict. His research has been published in the Quarterly Journal of Economics, the American Economic Review, the Journal of Labor Economics, and Economic Journal, among others.

The ENS Program, established in late 2003, is an inter-mural program aiming to initiate, encourage, and facilitate high quality academic research and policy position papers on the interconnections between economics and defense. The close links between economic strength and development on one hand, and defense capabilities and security on the other are well recognized. Nevertheless, there is little theoretical and empirical research on these links by the academic community in Israel available to support policy making in these critically important matters. The Program holds periodic research meetings, organizes workshops on defense economics, and provides financial support on a competitive basis to proposals by researchers and graduate students submitted in response to widely circulated Calls for Proposals. Program participants include economists and researchers in other disciplines from various universities in Israel, research departments in the Bank of Israel and other government agencies, and some current and past officials in government and defense related organizations and industries. The Program Director is Prof. Dan Peled and the Coordinator is Col. (Res.) Moshe Elad.

Samuel Neaman Institute
for Advanced Studies in Science and Technology
Technion-Israel Institute of Technology
Technion City, Haifa 32000, Israel
Tel: 04-8292329, Fax: 04-8231889
www.neaman.org.il