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Do Fences Make Good Neighbors? Evidence from an Insurgency in India

Heidi Kaila*, Saurabh Singhal† and Divya Tuteja‡

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Abstract: India has employed a variety of military, political and economic measures to combat the long running insurgency in Kashmir with little evidence on what contributes to stability in the region. This paper uses a variety of tests to detect structural breaks in the time series for violence over the period 1998-2014. We identify a transition from a high violence regime to a low violence regime that coincides with (i) the fencing of the border with Pakistan (ii) the implementation of a large-scale development program, and (iii) the phasing in of the Indian National Rural Employment Guarantee Scheme (NREGS). Panel data analysis using district-level data further corroborate these findings. Our results highlight the complementary roles of development programs and security in reducing violence.

Keywords: Conflict, Multiple Structural Breaks, Nonlinear Time Series Models, Jammu and Kashmir, Fixed Effects

JEL Codes: C22, D74, F51.

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* kaila.heidik@gmail.com (corresponding author); Cornell University

† s.singhal1@lancaster.ac.uk; Lancaster University

‡ divya@iift.edu; Indian Institute of Foreign Trade, Delhi

1 Introduction

While the number of inter-state and civil wars has declined over time, close to 1.5 billion people remain affected by fragility, conflict and violence (World Bank, 2011). Undoubtedly, poverty and conflict go hand-in-hand and policymakers in developing countries continue to grapple with policies that could end the recurrent cycles of poverty and violence. In particular, researchers and policymakers have been demonstrating an increasing interest in examining the utility of development programs in the context of conflict reduction and the conditions necessary for their success. However, isolating the effect of such policies is complex, given that multiple policies maybe simultaneously implemented. In this paper, we utilize a variety of time series and panel data techniques to assess several policies implemented in the context of the ongoing insurgency in Jammu and Kashmir state of India.

Beset with numerous insurgencies within its borders since independence, India has employed a combination of military, political and economic measures to combat them, yet there is little evidence on what factors may have contributed to stability. One such case is that of the ongoing conflict in the Indian-controlled state of Jammu and Kashmir. Both India and Pakistan claim territorial control over Kashmir with each currently controlling two-thirds and one-third of the area, respectively. The current insurgency started in 1989 with separatists, backed by Pakistan, contesting control of the Indian government (Chadha, 2005; Habibullah, 2008). A key security policy implemented to counter the insurgency was fencing of the Line of Control (LoC), the de facto border between Indian and Pakistan controlled parts of Kashmir, by the end of 2004. This was followed by the introduction of two large-scale development programs - the Indian National Rural Employment Guarantee Scheme (NREGS) and the Prime Minister's Reconstruction Plan for J&K (PMRP) in the state.

While understanding the linkages between conflict and socio-economic outcomes has long been considered important, there has been a recent shift in focus towards the effects of counterinsurgency policies in the last decade primarily due to the wars in Iraq and Afghanistan (Berman and Matanock, 2015; Blattman and Ralston, 2015; Beath et al., 2013). Although government forces are typically better equipped than insurgents, civilian support often plays a large part in successful operations. Cognizant of this, the "hearts and minds" approach aims to win over the population by providing them public services, with the expectation that once their grievances are addressed, the attitude of the population towards the government will improve. The civilians are then less likely to help or join the insurgents and more likely to share information with the counterinsurgents. Berman et al. (2011) find that improved service provision through the Commanders Emergency Reconstruction Program (CERP) in Iraq reduced violence, especially in the case of small-scale projects implemented in consultation with local leaders.

A second related counterinsurgency mechanism banks on the opportunity-cost mechanism approach, which posits that an improved economic environment, access to markets, labor market conditions, etc. increase the cost of participating in the insurgency and reduces the supply of insurgents. In addition to cross-country studies of Collier and Hoeffler (2004), and Miguel et al. (2004), the opportunity cost mechanism finds support in a number of individual-level studies as well. Dube and Vargas (2013) exploit municipality level variation in dependence on labor-intensive agricultural sector, to find that sharp drops in the international price of agricultural commodities increased violence in Colombia. Miaari et al. (2014) examine how restrictions on the employment of Palestinians in Israel following the outbreak of the Second Intifada affected the involvement of Palestinians in the conflict. Exploiting spatial differences in the decline of employment opportunities for Palestinians, they find a 1% point decline in the employment rate to be associated with an increase of 0.11 Palestinian fatalities. Similarly, Iyengar et al. (2011) find that labor-intensive projects under the CERP reduced violence levels in Iraq.

On the other hand, it is also possible that such development programs could attract more violence though rent seeking or predatory behavior on the part of the insurgents (rapacity effect). In the study mentioned above, Dube and Vargas (2013) find that an increase in the price of oil (a natural resource where extraction is not labor-intensive) increased municipality revenue and violence in oil-dependent regions of Colombia. Insurgents may also try to sabotage developmental activities in an effort to undermine the government. For example, Crost et al. (2014) find that districts eligible for the KALAHI-CIDSS development assistance program in the Philippines witnessed an increase in violence. The authors' hypothesis is that this is due to insurgents strategically trying to sabotage projects. Similarly, Beath et al. (2013) find that even though the National Solidarity Program (NSP) in Afghanistan improved villagers' perception of the government, its effect on security was temporary and dissipated over time.

Thus, a crucial determinant of the success of development programs in reducing violence may be a sufficiently low initial level of violence. This implies that security and development programs may complement each other, such that security policy must be effective first if initial violence levels are high. Indeed, Berman et al. (2013) argue that troop deployments and the resulting improvements in security played a crucial role in the success of the CERP program in Iraq. Emerging evidence from Afghanistan points to a similar relationship. Using geo-coded data, Sexton (2016) finds counter-insurgency aid reduced violence in areas that were already under the control of pro-government forces and Beath et al. (2013) find that the NSP program only had a positive effect on security in villages that had low initial levels of violence.[1] This paper further highlights the role played by improved security in the effectiveness of development programs in reducing violence. Using a variety of time series and panel data techniques, we find that fencing of the border between India and Pakistan reduced the level of violence in the Indian state of Jammu and Kashmir by restricting the supply of insurgents. Development programs implemented subsequently in the improved security environment further reduced violence, particularly in the form of civilian casualties.

In this paper, we use various endogenous structural break models to test if the fencing of the LoC and the implementation of the PMRP and NREGS lead to structural changes in the insurgency in Jammu and Kashmir. Even when the start date is known, policy interventions may affect outcomes gradually over time making it difficult to precisely *ex-ante* identify a break date in the outcome variable. We explore a smooth break in the time series by employing Logistic Smooth Transition Regression (LSTR) with time as the threshold variable, and find that the level of violence depicts a nonlinear break centered around the beginning of 2005, corresponding to the fencing of the LoC. Estimates from the Bai and Perron (1998, 2003) methodology to detect multiple unknown structural breaks further underscore this result. Our results are robust to different model specifications and transformations of the data. We find a significant structural change marked by a decline in the insurgency (particularly the number of insurgents killed) in 2005. This is followed by a decline in the number of civilian and security forces casualties in 2006-07, indicating that the improved security coupled with the introduction of two large-scale development programs, the PMRP and NREGS, further helped reduce violence in the state. This pattern in the timing of breaks is indicative of the causal factors that may have been at play during the period of declining violence in the state.

Panel data analysis using district-level violence data further corroborate these findings. We find that relative to districts away from the border, insurgent (civilian) casualties increased (decreased) in districts bordering Pakistan after the completion of the fence - suggesting that the fence increased security at the border, possibly enabling security personnel to better

[1]In a recent systematic review of the existing literature, Zürcher (2017) finds that aid reduces violence conditional on there being a secure environment for the implementation of aid projects.

target insurgents, thereby reducing civilian deaths.

This paper contributes to the literature examining conflict in India. In the Indian context, Muralidharan et al. (2017) find that NREGS increased earnings of low-income households, primarily via increase in private sector wages. However, the evidence on the effect of NREGS on the long-running Maoist violence in central and eastern India is mixed. While Khanna and Zimmermann (2017) find that it increased violence in the short-run, Dasgupta et al. (2017) and Fetzer (2014) find that it reduced violence levels most likely due to the significant rural poverty reductions associated with the program.[2] Our results indicate that development programs are related to reduction in violence, albeit in the presence of improved security.

Finally, this paper also contributes to the use of nonlinear time series methods in the study of conflict. To our knowledge, the existing studies on conflict which are based on time series analysis only employ methods that detect sharp breaks, mainly using the Bai and Perron procedure (Bai and Perron, 1998; 2003).[3] For example, Amara (2012) utilizes a combination of endogenous sharp break models along with exogenous structural break tests of Chow (1960) and Quandt-Andrews (Andrews, 1993) to study the relationship between the U.S. military 'surge' and economic and security stability in Iraq. Similarly, using endogenous (but sharp) structural breaks, Enders and Sandler (2005) study incidents of transnational terrorism with a focus on the changes that may have been triggered by 9/11.[4] We focus, instead, on endogenous smooth breaks inferred using the LSTR framework in addition to sharp breaks given by the Bai and Perron procedure. This is because ongoing conflicts are more likely to adjust gradually to a long-run equilibrium than exhibit sharp movements. The presence of non-linearities in our data allows us to gain a deeper understanding of the evolution of smooth breaks and violence in the state. It is noteworthy that both the smooth and sharp breaks are detected without *a priori* assuming the dates when they take place. Our methodology, hence, lets "the data speak for itself".

The rest of the paper is organized as follows. In Section 2 we provide an overview of the ongoing conflict in the Indian state of Jammu and Kashmir. Section 3 discusses the data. Section 4 outlines the empirical strategy and the data used in the study. The results are presented in Section 5 and Section 6 concludes.

[2]In related work, Singhal and Nilakantan (2016) assess the effectiveness of a security policy implemented to combat the Maoist insurgency.

[3]An exception is Enders et al. (2016) that finds a nonlinear relationship between income level and terrorism.

[4]Other papers which have employed sharp breaks in the context of conflict studies include Oosterlinck (2003), Waldenström and Frey (2008), and Chaney (2008).

2 The context: Insurgency in Jammu and Kashmir

The low intensity conflict that started in 1989 is rooted in the dispute between India and Pakistan over the territory of Kashmir, ongoing since the partition of the Indian subcontinent in 1947. Currently, India and Pakistan control two-thirds and one-third of the original state of Jammu and Kashmir, respectively. The dispute has led to two open wars, in 1947 and 1965, and brought the two countries close to war on a number of other occasions. A map of the region is provided in Figure A1 in the online Appendix.

The current armed insurgency started in 1989 in the Kashmir Valley, spreading over time to other parts of the state. A variety of factors contributed to the rise and spread of the violent insurgency, including widespread discontent with elections in the state and active support from Pakistan in the form of arms and training (Business Standard, 2015; Chadha, 2005).[5] The Indian army was summoned to quell the insurgency and it continues to run the counter-insurgency operations in the state in conjunction with central and state police forces. During the period from 1998 to 2014, the insurgency resulted in over 25,000 deaths (Source: SATP). However, as shown in Figure 1, the number of casualties has reduced drastically since 2005. The average number of yearly casualties has fallen from 2569 during the period 1991-2005 to 403 in the following decade (Source: SATP). In addition to the considerable loss of life, recent research also finds that children born during the conflict are smaller and complete lesser years of schooling (Parlow, 2011 and 2012).

Table 1 lists the important events related to the insurgency in Jammu and Kashmir. Figure 1 displays the timeline of the events along with the total monthly casualties during the insurgency. One of the important incidents involved the Kargil war and its aftermath. In early spring of 1999, armed intruders were discovered to have taken over strategic positions on the Indian side of the LoC. The Indian army was mobilized and moved to the border areas to repel the intruders. The war ended shortly in July when the Indian army successfully repulsed the intruders and chose not to widen to conflict with Pakistan. The quick movement of the army to the border regions disrupted their regular counterinsurgency operations in the interior regions. As a result, the interior areas vacated by the army were occupied by insurgents. Following the end of the Kargil war, the army had to (re)contest for control of the interior regions leading to an increase in violence that only came down by 2003, when

[5]The end of the Soviet occupation in neighboring Afghanistan in 1989 also resulted in the availability of excess arms and experienced fighters. For a more detailed discussion of the conflict in Jammu and Kashmir, see Chadha (2005).

India and Pakistan restored diplomatic ties and agreed to a cease-fire along the LoC (BBC News, 2003).

The Indian government has used a blend of military, political and economic policies to combat the insurgency (Staniland, 2013; Ganguly, 2009). On the political front, the government has engaged with Pakistan at various points of time without any apparent success (except for the 2003 cease-fire agreement that has held despite a few violations). For example, a ceasefire negotiated with the primary militant groups from November 2000 to May 2001 collapsed without making much headway. The most significant political change in the 2000s has been the successful implementation of state elections. The state was under the President's Rule (i.e., the central government) for most of the 1990s and the dominant regional political party Jammu Kashmir National Conference (JKNC) was viewed as corrupt. The 2002 elections were a watershed in the electoral history of the state, allowing the popular Jammu Kashmir Peoples Democratic Party (PDP) to take charge (in coalition with the Indian National Congress, INC).

One of the key security measures undertaken by the government has been fencing the border with Pakistan. In terms of economic interventions, the notable intervention in the state during this time period was the introduction of the Prime Minister's Reconstruction Plan for J&K (PMRP) in 2005. Following this, the Indian National Rural Employment Guarantee Scheme (NREGS) was rolled out in the state over the period 2006-08. These policies are discussed in greater detail below.

2.1 Fencing of the Line of Control

The erstwhile princely state of Jammu and Kashmir is delineated into the Indian and Pakistan controlled parts by the "Line of Control (LoC)".[6,7] India has fenced its border with Pakistan, both international and the LoC (Waldman, 2004). Fencing of the LoC, around 550 kilometers of the 740 kilometers allowing for breaks in the terrain, was completed by September 2004 and Indian security forces estimate that it has been particularly successful in reducing the infiltration of insurgents from Pakistan (Times of India, 2004; The Indian Express, 2014). Figure A4 in the online Appendix 4 displays a photograph of the fence.

[6] This was originally called the Cease-fire line following the first war in 1947-48. It was re-designated as the "Line of Control" after the Shimla Agreement in 1972. While the Line of Control is not internationally recognized, it is considered the de-facto border between India and Pakistan.

[7] A small section of the border between Indian and Pakistan controlled parts is part of the internationally recognized border.

2.2 Prime Minister's Reconstruction Plan for J&K (PMRP)

The PMRP was announced by Prime Minister Dr. Manmohan Singh in November 2004. The objective of the plan was the long-term development of the state through the creation of infrastructure, provision of basic services, and creation of jobs. The infrastructure projects included within the ambit of the plan are expansion of the road network, power generation projects, rural electrification, construction of health centers and Anganwadis, and the construction of colleges.[8,9] Support was provided for the tourism industry through modernization of airports, conservation programs for various lakes, construction of tourist villages and training support for those in the tourism and hospitality industry. Income and employment generation in the agricultural sector was supported through various programs in the horticultural industry and construction of food storage units.[10]

As of August 2015, 36 out of 67 sanctioned projects had been completed. While the central government had allocated approximately 240 billion Rupees (or 4 billion USD at the exchange rate of 1 USD = 60 Rupees) for the initial four-year period (2005-08), as of March 2014, over 780 billion Rupees (13 billion USD) have been disbursed under the scheme. The yearly expenditures of the reconstruction plan are displayed in Figure 2.

2.3 National Rural Employment Guarantee Scheme (NREGS)

The NREGS guarantees 100 days of manual work at the minimum wage to all rural Indian households. The objective is to protect the livelihood of rural households in times of dire need and is considered to be one of the largest safety net programs in the world. The National Rural Employment Guarantee Act (NREGA) was passed into law in August 2005 and the NREGS was phased in, in a non-random manner, between 2006 and 2008. More specifically, the NREGS was rolled out in three phases in India: in Phase 1, 200 districts received the scheme beginning February 2006; in Phase 2, an additional 130 districts were added to the program starting April 2007; and finally, in Phase 3 all the remaining districts were covered in April 2008. In Jammu and Kashmir, 3 districts were covered under Phase 1 namely Doda, Kupwara and Poonch. In Phase 2, Anantnag and Jammu were added to the

[8] Anganwadis are government funded child-care centers in India.

[9] Some of the rural electrification objectives are included under the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), a large India-wide program launched in 2005 with the objective of providing electricity access to hitherto un-electrified villages.

[10] The plan also provided funds for the rehabilitation of families affected by militancy in the state. Further details are available at `<http://pib.nic.in/newsite/erelcontent.aspx?relid=4947>` (accessed Jan 18, 2016).

scheme and, finally, the scheme was operational in all districts of the state by the start of Phase 3.[11]

3 Data

In order to assess changes in violence in Jammu and Kashmir we use data on the number of casualties, and the number of incidents involving the use of explosives (landmines, grenades, IEDs, etc.). Both are available at the monthly level and are collected from the website of the South Asian Terrorism Portal (SATP), which bases these estimates on newspaper reports on terrorism related incidents in Jammu and Kashmir.[12] While the data on the number of incidents involving explosives are available from January 2001 to December 2014, the data on the number of casualties are available for the period January 1998 to December 2014. We are able to disaggregate the data on casualties further into three categories - the number of civilians, security personnel, and insurgents killed - which allows us to examine if the results are driven by violence against a particular group.

We also differentiate foreign insurgents from the aggregate number of insurgents by using police records on the number of foreign insurgents killed during the period January 2003-December 2010.[13] While the records are available for the period October 1998-April 2010, no foreign insurgent casualties are reported for the period April 2002-June 2003. Given the number of casualties reported before and after this period, we regard this data as missing and only consider data from July 2003-December 2010 for our analysis. The descriptive statistics are reported in Table 2 and the time series are plotted in Figure 3 (Panels 3a to 3f).

Lastly, in order to conduct a district-level analysis we transcribe reports of 'major' violent incidents from SATP to determine location of events and the number of casualties. These are terrorism-related events with at least three fatalities per incident. This data ranges from January 2000 to December 2014. The district boundaries have changed during this period with larger districts being split into smaller ones. While the state is currently divided into 22 districts, we merge newer districts into the older ones for consistency.

[11] NREGA was later renamed Mahatma Gandhi National Rural Employment Guarantee Act. Further details regarding the policy are available at <www.nrega.nic.in/> (accessed Jan 18, 2016).

[12] See <http://www.satp.org/> for details.

[13] These data were obtained from the J&K police website (<http://www.jkpolice.gov.in/index.htm>) in 2014.

4 Empirical Methodology

In this section we describe the empirical methodologies used in this study. First, motivated by the nonlinear nature of our data, we use the logistic smooth transition regression (LSTR) methods to discern nonlinear structural changes in the violence data. Thereafter, we use Bai and Perron (1998, 2003) technique to detect multiple sharp structural breaks in keeping with the existing literature that utilizes time-series methods to identify structural breaks in conflicts (Enders and Sandler 2005; Amara 2012). Finally, we also use a Poisson fixed effects model to conduct a district-level panel data analysis.

However, before proceeding to the structural break analysis, we check for the existence of unit roots and the existence and nature of the non-linearities in our data, to assess whether our break tests are indeed methodologically appropriate for our data.

4.1 Unit Root and Non-Linearity tests

We check for the presence of unit roots in all the series in the following way. In view of suspected structural breaks in our data, we conduct the Lee and Strazicich test for the presence of a unit root with structural breaks.[14] Before conducting the test, we select the optimal lag length for the unit root tests using the conventional lag length criterion, that is, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Hannan-Quinn (HQ) and F-statistic along with the lag exclusion tests.[15] The null hypothesis of a unit root process in the presence of structural breaks in rejected at 1% level of significance in all the cases (Table A1 of the online Appendix). Therefore, we conclude that the series are stationary in levels.

Next, given that smooth structural breaks are a form of non-linear time-series, we test if all the violence time series are indeed non-linear, before proceeding with estimation of the Logistic Smooth Transition Regression (LSTR) model. We do so by using the tests proposed by Tsay (1986) and Luukkonen et al. (1988) where the null hypothesis is linearity. The alternative hypothesis of Tsay's test is nonlinearity while that of Luukkonen et al. (1988)'s test is nonlinearity of the smooth transition autoregressive (STAR) model type. Results of both tests shown in the online Appendix Table A2 and indicate that all the time series on

[14]Lee and Strazicich (2003) propose a two-break minimum LM unit root test with breaks in the level and trend under the null hypothesis which they argue, conclusively implies trend stationarity under the alternative hypothesis.

[15]Detailed results of the lag selection and lag exclusion tests are available with the authors on request.

violence are non-linear. In particular, results of the Luukkonen et al. (1988) test suggest that a model that belongs to the smooth transition family may be appropriate.

Finally, after confirming that the data are indeed non-linear and stationary, we test for the existence of nonlinear breaks (that is, the appropriateness of the LSTR model with time as the threshold variable) using the following auxiliary regression equation (Enders, 2015):

$$y_t = a_0 + a_1 t + a_2 t^2 + a_3 t^3 + \sum_{i=1}^{p} b_i y_{t-i} + \varepsilon_t \tag{1}$$

where, in order to test for the existence of a LSTR break, we test the null hypothesis that $a_1 = a_2 = a_3 = 0$.[16] The results are reported in Table A3 in Appendix A1.2. The F-statistic corresponds to the null hypothesis of no smooth transition in the threshold variable, time. The null hypothesis is rejected in all the five cases at 1% level, confirming the existence of a smooth transition regression process with time as the threshold variable.

4.2 Logistic Smooth Transition Regression (LSTR)

Over a period of time, economic variables often go through gradual structural changes. One of the possible reasons for such phenomena is a slow reaction of economic agents to policy measures. Therefore, in our analysis, we focus on the possibility of such slow structural breaks, i.e. smooth breaks in the data. The models of smooth breaks fall into the category of non-linear structural breaks.

Given that we have found the data to be non-linear in nature, and that we have found that a smooth transition regression is an appropriate fit for the data, next we present the LSTR model with time as the threshold variable (Teräsvirta, 1994; 1998; Lin and Teräsvirta, 1994; Enders, 2015), to be estimated, in order to understand the exact break patterns in our data.

The non-linear Logistic Smooth Transition Regression model estimated takes the form:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \lambda_0 [1 + \exp(-\gamma (t - c))\,]^{-1} + u_t \tag{2}$$

[16] Equation 1 is a Taylor series expansion of the transition function $[1 + \exp(-\gamma (t - c))\,]^{-1}$ (Lin and Teräsvirta, 1994), which is discussed in detail in the next section, where the LSTR model is thoroughly introduced.

where y_t is the dependent variable, such as the number of total casualties at time t, and $y_{t-1}, \ldots, y_{t-p}$ are its past realizations, and $\alpha_1, \ldots, \alpha_p$ are the respective AR-coefficients. The lag length p is chosen by using standard lag selection procedures, explained in detail alongside the results, α_0 is a constant, and u_t is the error term.

The logistic transition function is described by $[1 + \exp(-\gamma (t - c))]^{-1}$, and is multiplied by a constant λ_0. We are interested in the parameters of the transition function for our analysis: time t is the threshold variable, that is, the logistic function takes values from 0 to 1 as t increases. Our main interest lies in the centrality parameter c, which indicates the mid-point in the logistic transition curve which governs the point of movement from one regime to another (or the smooth break). The smoothness parameter γ determines how smooth or sharp the curve is, as it affects the slope of the curve. A higher value of γ will imply a sharper shift at the breakpoint. The LSTR model implies a change in the intercept when moving from one regime to another, as over time, the value of the logistic curve goes from 0 to 1. That is, the intercept gradually changes via the logistic curve from α_0 to $\alpha_0 + \lambda_0$ (where λ_0 may be negative such as in our case).[17]

4.3 Bai and Perron (BP) Methodology

In addition to estimating smooth breaks that allow a gradual shift over time, we also use the Bai and Perron model (1998 and 2003) to detect sharp breaks in the time series. While this method is commonly used in the literature (for example, Amara 2012), sharp breaks imply that a shift in the series occurs at a specific break date, without any transition period. Therefore it is natural to assume that also the economic environment in which we detect a sharp break are different from the kind of conditions that lead to a smooth gradual transition.

The Bai and Perron (BP) model estimated in our main specification takes the form:

$$y_t = \delta_{1j} + \delta_{2j} t + u_t, \quad t = T_{j-1} + 1, \ \ldots, \ T_j \tag{3}$$

Where y_t is the variable of interest. The constant δ_1 and the trend term $\delta_2 t$ vary across each regime j, where $j = 1, \ldots, m + 1$, and the break points are denoted $T_1, \ldots, T_m$, using the notation in Bai & Perron that $T_0 = 0$ and $T_{m+1} = T$. The breakpoints and hence the length

[17] We also examined a model that has trend terms in addition to the constants, but the trend was not statistically significant. Results are available from the authors.

of each regime j are ex-ante unknown. u_t is the error term.

To estimate the BP procedure, we first need to determine the number of breaks m (and hence, regimes $m+1$) in the data. Then, given the number of break points, we estimate the BP model in equation 3, which endogenously determines where in the time-series the break points $T_1, \ldots, T_m$ occur.

As a robustness check, we also augment equation 3 with AR-terms as exogenous regressors.[18] The model then becomes:

$$y_t = \delta_{1j} + \delta_{2j}t + \beta_i \sum_{i=1}^{p} y_{t-i} + u_t, \quad t = T_{j-1}+1,\ \ldots,\ T_j \tag{4}$$

where p is the number of lags.

Various test statistics can be employed to determine the number of breaks given a maximum number of breaks m.[19] The $F\,(l+1|\,l)$ test statistic tests the hypothesis of $l+1$ against l structural breaks and the $supF(k;q)$ test statistic tests the hypothesis of zero breaks against k breaks with q break parameters (i.e., endogenous regressors). The UDmax statistic tests the null hypothesis of no structural break against an unknown number of breaks.

To determine the exact number of breaks m one can use several information criteria: BIC (Bayesian Information Criterion), LWZ (Modified Schwarz Criterion) or a sequential procedure based on the $(l+1|\,l)$ test statistic. Bai and Perron (2003) point out that when breaks are present, BIC performs well, while LWZ performs better under the null and might underestimate the number of breaks when the null is rejected. Further, the sequential procedure may perform poorly if the series is highly persistent (Enders, 2015). Since our data display high persistence and the UD max and $supF(k;q)$ statistic firmly reject the null, we use the BIC procedure to determine the number of breaks.

4.4 Poisson fixed effects model

Lastly we also examine the relationship between district level violence and the key interventions (PMRP, NREGA and the fencing of the LoC) using a conditional Poisson fixed effects model (Hausman, Hall, and Griliches 1984; Wooldridge 1999) that accounts for the fact that

[18] The selection of the number of lags k is done by using standard procedures for lag selection and presented alongside the results.

[19] Bai and Perron (2003) provide examples with $m = 5$.

the violence data are count variables. The Poisson fixed effects model takes the following form:

$$
\begin{aligned}
y_{imt} = \alpha_i \exp\big(&\text{Border fence}_{mt} + \text{Border fence}_{mt} \times \text{Border dist}_i + PMRP_{mt} \\
&+ NREGS_{imt} + NREGS1_i + NREGS2_i + NREGS3_i + \lambda_t + \mu_m + \varepsilon_{imt}\big)
\end{aligned} \tag{5}
$$

where y_{imt} is the violence indicator in district i in month m and year t, and α_i are the district fixed effects. Border fence_{mt} is a dummy variable that indicates the completion of the fence, and takes the value 0 before October 2004 and 1 thereafter. The variable Border dist_i is a dummy for the districts that border Pakistan (Baramulla, Jammu, Kupwara, Poonch and Rajauri). The interaction term Border $\text{fence}_{mt} \times$ Border dist_i captures the effect of the fence on the bordering districts after its completion. $NREGS_{imt}$ is a dummy variable that takes the value 1 if district i is exposed to NREGS in month m and year t and 0 otherwise; and $PMRP_{mt}$ denotes monthly expenditures under the prime minister's reconstruction plan.[20] Finally, $NREGS1_i$, $NREGS2_i$ and $NREGS3_i$ are dummies for the phase 1, 2 and 3 districts of NREGS, respectively, that capture any time invariant unobservables common to districts chosen for a particular phase of the NREGS. λ_t are year fixed effects that capture common yearly events (eg. elections) and μ_m are month fixed effects that control for seasonal fluctuations. ε_{imt} is the error, which we cluster at the district level.

5 Results

This section presents results of the time series analysis of the casualties and incidents involving explosives during the insurgency in Jammu and Kashmir. To begin with, we investigate the existence of nonlinear smooth breaks and sharp breaks to understand the evolution of the conflict. This is followed by a brief discussion of robustness checks and panel data analysis.

5.1 Nonlinear Breaks

As discussed in Section 4.2, most economic time series in our data depict a smooth break, which takes place over a period of time. In order to capture smooth breaks, we resort to

[20] PMRP expenditures are not available at the district level. While the PMRP expenditures are for the fiscal year (April to March, starting April 2005), we divide them by 12 to get average monthly expenditures.

smooth transition regression models.

First we need to select the optimal lag for the nonlinear models. Following Franses and van Djik (2000), we choose optimal lag lengths based on the information criterion (AIC, BIC and HQ) and then estimate the corresponding nonlinear models using the suggested lag lengths. We estimate the LSTR model with the optimal lag lengths and pare down lags in the model by dropping variables which are insignificant. We finally select one lag for the civilian, insurgent and total casualties, two lags for security personnel casualties, and one lag for incidents involving explosives.[21]

The estimates of the LSTR models for the series are given in Table 3. Table 3a provides results from estimating the LSTR model: the break dates, i.e. the centrality parameter c for the time series for casualties as well as incidents involving explosives. We find that the dates for all the four series on casualties are clustered around January to April 2005, while the break date for the incidents involving explosives is June 2006.[22]

Table 3b provides the descriptive statistics of the violence series across the high, transition and low violence regimes. We observe that there was a secular decline in violence in the state of Jammu and Kashmir over the period of study. There appear to exist two states in the all the time series on casualties: a high casualties state until 2003 and a state of low casualties from 2007 onwards. The period in between, from 2003 to 2006, is the transition period from the high to the low violence regime that indicates presence of a smooth break. We also observe that the transition from the high to low violence regime is accompanied by a decline in the maximum, minimum, and average levels of violence.

We present the full results of estimating the LSTR model given in equation 2 in Table A4 of the online Appendix.[23] It is notable that λ_0 is negative in all the cases which signifies that the mean of the process is decreasing as $\theta \to 1$. The transition functions for the series depicting the number of casualties have been plotted in Figure A2 of the online Appendix, which show the trend of declining violence. The Ljung-box statistics for the residuals of the series show that there is no remaining serial correlation at 1% level of significance, and the

[21] Due to the lack of data in the number of foreign insurgents killed series, we do not perform the LSTR analysis for this violence indicator.

[22] The results for nonlinear break dates are robust across grid search procedures and different starting values.

[23] We also estimate the LSTR models with two smoothed breaks for all the series. The modified AIC statistic (Enders and Holt, 2012) is utilized to select the final model, $AIC = T\log\left(\sum_{t=1}^{T}\hat{u}_t^2\right) + 2r$, where T is the number of time periods, r is the number of parameters estimated in the respective models and i $\hat{u}_t$ are the residuals of the model. The best model in all the cases is the LSTR model with a single smooth break.

model specification is appropriate.

Recall that the series for incidents involving explosives is truncated as data are only available from 2001 onwards. Nonetheless, results from the nonlinear model are similar: a high violence regime with incidents involving explosives stretches until mid-2003, and then the series transitions up to early 2009 to a low violence regime.

Finally, Figure 4 (Figures 4a to 4e) illustrate the results from the LSTR model.[24] The green lines display the data, while the dashed orange line display the predicted values given by the LSTR model, that is, the fit of the model.[25] The dashed blue line denotes the centrality parameter, that is, the center of the logistic break. The solid blue lines depict the sharp breaks discussed in the next section.

5.2 Bai and Perron (BP) Breaks

In this sub-section, we first discuss the exact break dates found by BP procedure and the events that coincide with these breaks. Thereafter, we relate these breaks to the smooth breaks that we detected and discuss the overall evidence.

Table 4 displays results of the BP procedure, i.e. results from estimating equation 3, where the number of breaks (m) is selected by using BIC. Table 4 reports the point estimate for each break date, the 95 percent confidence intervals around the break dates (the columns Lower and Upper), as well as the estimated intercept and trend in the $(m + 1)$ regimes. Hence, in each row the last two columns report the mean and trend *prior* to the break date for the series.

We find four break dates in the total and insurgents casualties series, three each for civilian casualties and incidents involving explosions, two for security force personnel casualties, and one for foreign insurgents casualties series. As the total casualties series is the sum of insurgents, civilians and security force personnel killed, the break dates in this series provide an overall picture of violence in the state. Further, as the number of insurgent casualties constitute a large fraction of total casualties, the break dates observed in insurgent casualties series are similar to those in the total casualties series.

[24] Figure 4f shows the results for the foreign insurgents casualties series, in which we only analyze the sharp breaks due to that time series being shorter.

[25] The fit of civilian casualties and explosives is not as accurate as that of the other time series, insofar as LSTR model seems to be underestimating the short-term fluctuations. Since our main interest is in the logistic break, the trend of the decline, which is captured accurately, we consider the LSTR fit to be adequate for the purpose for which the model is used.

The first break-point, identified in all the casualties series, is 2001 which marks the peak in the trend of casualties. The events explaining this break-point are related to, on one hand, diminished support to militant groups from Pakistan in the face of international scrutiny post 9/11 and, on the other hand, Indian security forces regaining control of urban areas lost due to troop movements during the Kargil war. A break-point in 1999 in the civilians killed series is also a possible result of the turbulence during that time period.

In the aggregate casualties series, we find the key break date to be March 2005. This comes shortly after the completion of the fencing of the LoC, indicating that the fence had a significant effect on the level of violence in the state. The break date also happens to coincide with the start of reconstruction plan (PMRP), although it should be noted that the launch of the program was announced earlier. Both the insurgents and foreign insurgents casualties series also capture the same break-point, as does the the incidents involving explosions series. Particularly the drop in the number of foreign insurgents casualties close to the completion of the fence highlights the importance of the fence in reducing the influx of foreign insurgents.

Interestingly, we find that the break-points for the civilian and security force personnel casualties series lag behind the break date for the insurgent casualties (2006 November for security force personnel and August 2007 for civilians, respectively). This possibly indicates that the improved security environment provided by the fencing of the LoC, allowed for effective implementation of the large economic development programs (PMRP and the NREGS), which in turn led to a decline in the number of casualties among civilians and security force personnel. The relation between security and the subsequent success of development programs in reducing violence is similar to that found for the case of Iraq and Afghanistan (Berman et al. 2013; Sexton 2016; Beath et al. 2013).

These break-points are followed by break-points in November 2006 for the total and security force personnel casualties series, in March 2007 for insurgent casualties, and in August 2007 for the civilians casualties and incidents involving explosions. These break-points are succeeded by a period where violence was lower and declining at a slower pace, especially in the incidents involving explosions series.

Finally, we also observe a break-point in early 2003 for the insurgent and total casualties. This break-point is characterized by decrease in violence, and it coincides with the year when India and Pakistan restored their diplomatic ties. This is also the year when the smooth transition of the LSTR model into the low-violence regime starts for all of the series.

Figures 4a to 4f depict the break-points obtained from BP and LSTR models. It is interesting to note that violence begins to decline from 2003 and transits to a low violence regime by the beginning of 2007 in all the cases. This is also the time period where the sharp BP breaks are clustered around the center of the transition function. Taken together, the evidence indicates that events taking place between 2003-2006 must have contributed to the reduction in the violence level. This period marks a change with the Indian troops recapturing interior areas post Kargil and the diplomatic dialogue between India and Pakistan resuming in 2003, fencing of the J&K border with Pakistan being completed in 2004, the PMRP coming into force in 2005 and, finally, NREGS being rolled out in 2006. Similarly, the BP and LSTR break dates for the incidents involving explosions are identified between late 2002 and 2008. Taken together, it seems that the nonlinear methodology captures the transition periods in the series while the BP technique re-emphasizes similar results by highlighting some of the key turning points in the series.

5.3 Robustness checks

We conduct a number of checks to assess the robustness of our findings. First, we check if the results are affected by seasonality. For instance, violence in the state is typically lower in the winter months. Therefore as a robustness check we re-estimate the LSTR models with seasonality adjusted series that obtained using the X-12-ARIMA adjustment. The robustness check of our main specification, the LSTR model, is presented in Table A5 in the online Appendix. The results for the deseasonalized data in Table A5 Panel (a) are similar to those given in Table A4. Compared to Table 3a, the break dates in Table A5a shift ahead by one month for the total, insurgent, and civilians casualties series, while it stays the same for security personnel casualties. However, in the case of the explosions series, the break date shifts back by about three months to March, 2006. Nonetheless, it should be noted that the break dates continue to fall in the same years (2005-06).[26]

Second, so far in the analysis we have utilized the violence count data without imposing a Poisson process on the time series models. An alternative approach would be to consider a linear mapping of the count data which maintains the order of the realizations in the original time series sequence. The transformed data constructed in such a way would no longer have counts. As a robustness check, we implement the LSTR model on such transformed data,

[26]The results for the BP estimation remain similar to the ones presented in the paper and are available from the authors on request.

which we calculate by standardizing the time series.[27] The results of the LSTR models for the standardized series are given in Table A6 in the online Appendix and indicate that the break dates are the same as those from the LSTR models for the non-standardized count data discussed above.

As a third robustness check we estimate equation 4, which extends equation 3 by adding AR terms as exogenous regressors to the Bai & Perron model (Enders and Sandler, 2005). The results are reported in Table A7 of the online Appendix and are similar to those reported in Table 4. While we find a few more break dates (four for civilians and three for security force personnel), the confidence intervals around the break dates are narrower, providing firmer evidence in favor of the break dates presented in Table 4. For instance, the confidence intervals of the 2005 breakpoints are just four months for the total casualties series, and three for the insurgents series. We also find a break point in April 2005 for the civilian casualties series, confirming our previous findings. Finally, the new break-point for security force personnel killed series in 2013 marks the time when the series converges to nearly zero.

Lastly, we also conduct Chow's (1960) test for the joint significance of the break dates detected using the Bai and Perron procedure and reject the null of no breaks at the 1% significance level in all the series[28]

5.4 District level analysis

Results from the time-series analysis, that endogenously detect a smooth as well as multiple sharp breaks in the data, indicate that there are structural breaks in violence in Jammu and Kashmir, and that the breaks coincide with three key events (fencing of the LoC, and the introduction of PMRP and NREGS). In this sub-section we further explore how these three events relate to the spatial distribution of violence over time. For this we use monthly district-level data on violence and estimate a Poisson fixed effects model (equation 5).

The results presented in Table 5 suggest that the policies that coincided with the decline in violence - the fencing of the LoC, the PMRP, and NREGS - contributed to reduction in violence in the state. Column 1 shows results for total casualties, and columns 2, 3 and 4 show the split between insurgents, security personnel and civilians, respectively.

[27]For a series x_t, the transformed series is given by $\tilde{x}_t = \frac{x_t - x_{mean}}{x_{standard\ deviation}}$.

[28]We test for a break in both in the constant and trend of the series. The results are available from the authors on request.

The variable Border Fence captures the effect of the completion of the fencing of the LoC on violence. In column 1 we find that the completion of the fence reduced total fatalities, although this effect is not statistically significant. Upon examining the effects by different groups we find that the fence significantly decreased insurgents and civilian deaths. While the fence had a negative effect on insurgent casualties, we find that insurgent casualties increased in districts bordering Pakistan after the completion of the fence relative to districts away from the border. Correspondingly, we find that reduction in violence towards civilians was even greater in districts bordering Pakistan after the completion of the fence. Taken together these results suggest that the completion of the fence increased security at the border, enabling security personnel to better target insurgents, thereby reducing civilian deaths.

Lastly upon examining the effects of NREGS and PMRP on total casualties we find that while both have the expected negative sign, the effects are not statistically significant. Upon disaggregating we find that the PMRP expenditures significantly reduced insurgent casualties, while NREGS significantly reduced casualties among security force personnel. In column 4 we find that both programs had a positive effect on civilian casualties. This is similar to the positive short-term effect of NREGS on Maoist conflict noted in Khanna and Zimmerman (2017). A possible explanation is that the introduction of the NREGA and PMRP programs led to an increase in civilian collaboration with security forces, and greater retaliatory violence against them by insurgents.

6 Conclusion

Over two and a half decades since the beginning of the conflict, the Indian government continues to search for policies to address the ongoing insurgency in Jammu and Kashmir. In this paper, we use a variety of time series techniques to assess the role played by several military, political and economic measures in reducing conflict in the state. The effect of policy interventions on conflict may gradually manifest over time, making it difficult to ex-ante pinpoint break dates in the time series data on violence. In this study, we go beyond the standard tests for sharp structural breaks used in the literature (Bai and Perron, 1998 and 2003; Chow, 1960; Andrews, 1993) by using endogenous nonlinear smooth break tests based on the LSTR model (Teräsvirta, 1994; 1998; Lin and Teräsvirta, 1994) to examine insurgency in the Indian state of Jammu and Kashmir over the period 1998-2014.

The nonlinear LSTR models indicate transition from a high violence state to a low violence state around 2005 corresponding to the fencing of the border between India and Pakistan. Subsequent large scale employment generation and infrastructure development programs implemented in the improved security environment coincided with a further reduced violence particularly that directed against civilians. The results from the Bai and Perron test procedure further validate these findings, and our results are robust to different model specifications and transformations of the data. This pattern in the timing of breaks is indicative of the causal factors that may have been at play during the period of declining violence in the state. Further, we also complement this analysis by using panel data methods to investigate the effects of these policies on violence in the state. The results provide suggestive evidence on the complementary relationship between security and development programs, which is supported by recent literature.

As further data becomes available, future research could extend the analysis to a more detailed micro level. As discussed earlier, Berman et al. (2011) find that small-scale projects implemented with local collaboration were successful in reducing violence in Iraq. While most the development projects in India are large in scale, spatial and temporal variation in their effect on violence and their interaction with security policies could provide a fruitful avenue to gain a deeper understanding of the effect of development programs on conflict.

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Figures and Tables

Figure 1: Timeline of Events

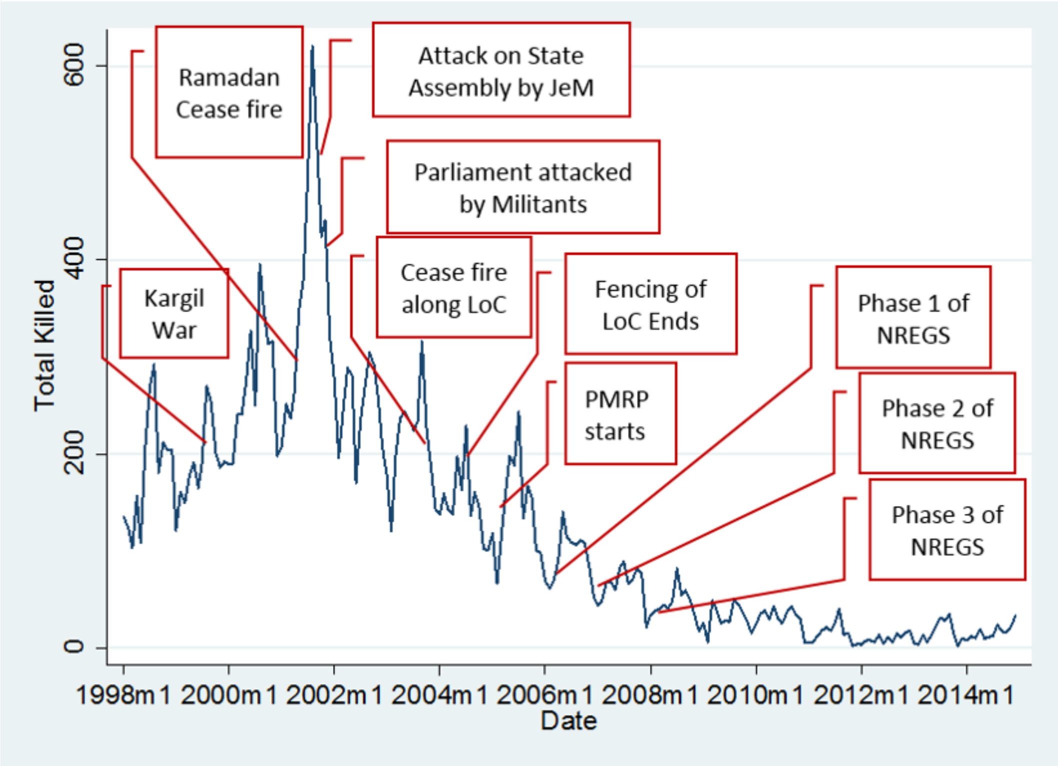
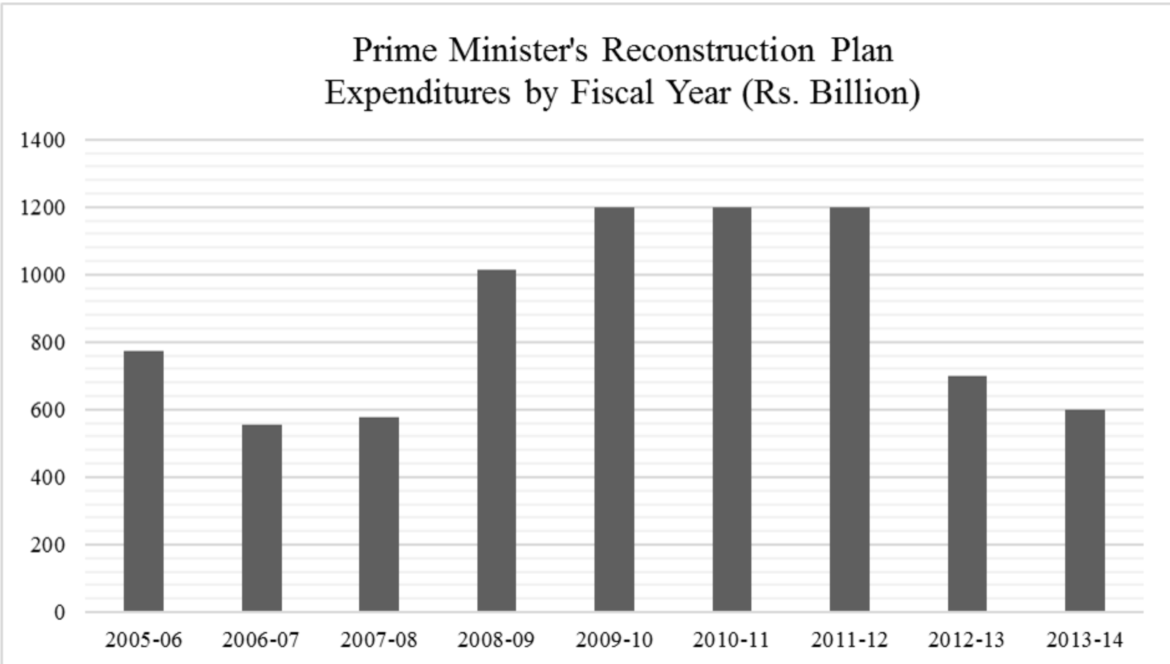
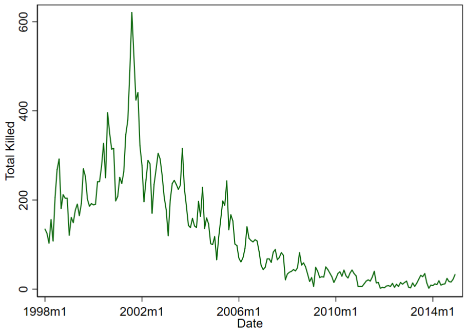


Figure 2: Expenditures of the Prime Minister's Reconstruction Plan

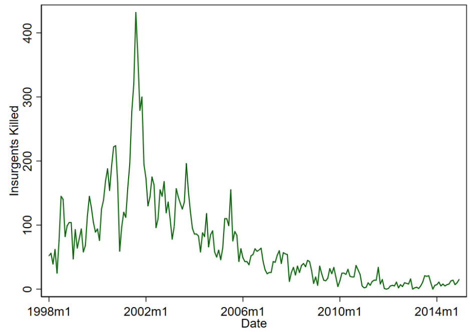


Source: Authors' calculations based on information received from the Ministry of Home Affairs, Government of India. All figures are in nominal terms.

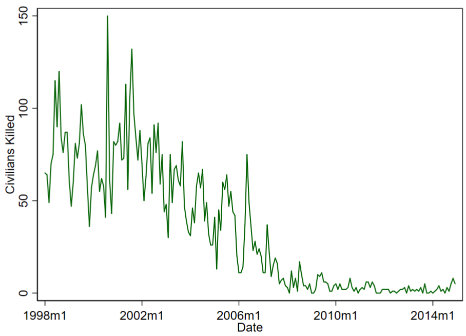
Figure 3: Time Series for casualties in Jammu and Kashmir



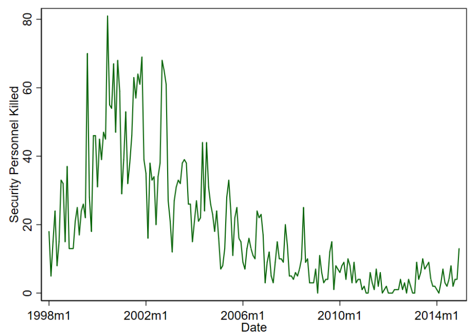
(a) Total Killed



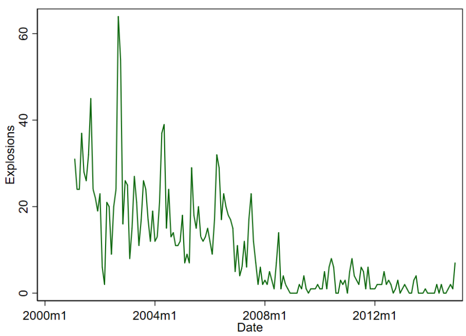
(b) Insurgents Killed



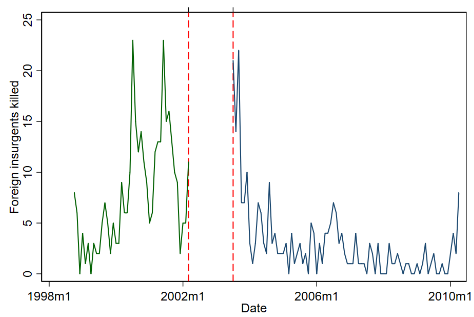
(c) Civilians Killed



(d) Security Personnel Killed

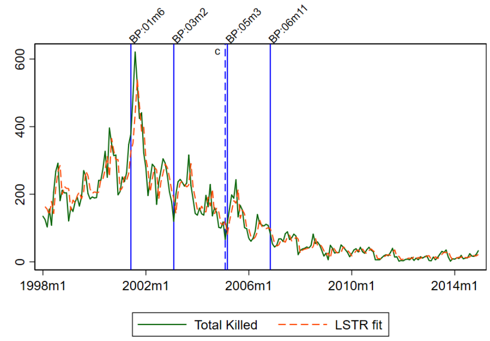


(e) Number of Incidents Involving Explosives

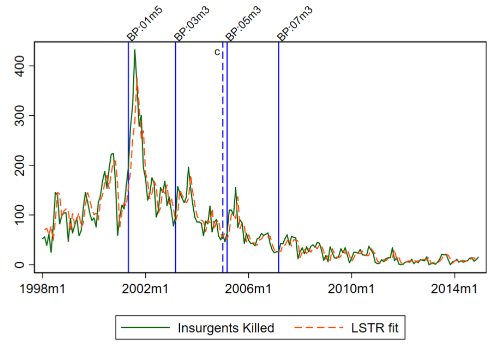


(f) Foreign Insurgents killed

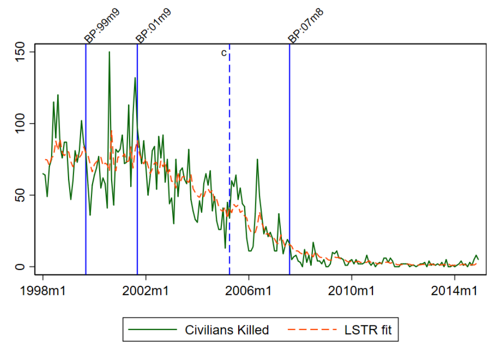
Figure 4: Structural Breaks



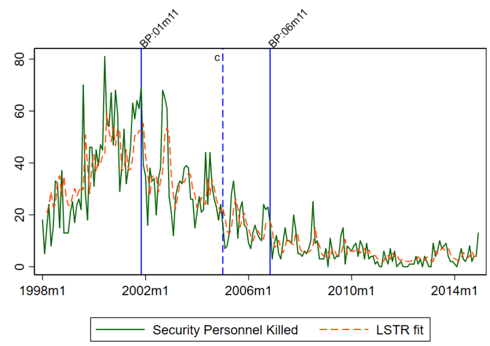
(a) Total Killed



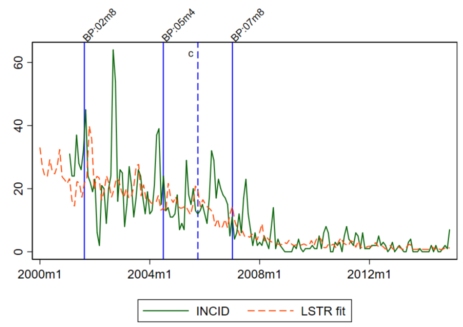
(b) Insurgents Killed



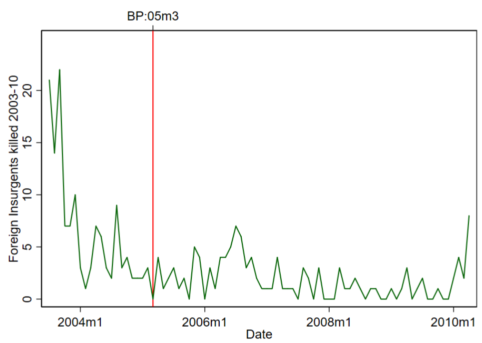
(c) Civilians Killed



(d) Security Personnel Killed



(e) Number of Incidents Involving Explosives



(f) Foreign insurgents killed

Notes: Green line displays the data and the orange dashed line the fit from the LSTR model. The vertical blue solid lines are the Bai and Perron break dates in Table 4, and the vertical blue dashed line shows the centrality parameter c of the LSTR model in Table 3a.

Table 1: List of Events

Date	Event
May-July 1999	Kargil War
Dec 2000- May 2001	Ramadan Cease fire
1st Oct 2001	Suicide attack by the JaisheMohammed (JeM) on the State Legislative Assembly complex in Srinagar
13th Dec 2001	Indian National Parliament attacked by Militants
Sept-Oct 2002	State elections, Jammu Kashmir Peoples Democratic Party (PDP) comes to power
25th Nov 2003	India and Pakistan agree to a cease-fire along the LoC
Sept 2004	LoC fencing completed
Nov 2004	PM's Reconstruction Plan (PMRP) announced.
April 2005	PMRP starts
Feb 2006	Phase 1 of NREGS
April 2007	Phase 2 of NREGS
April 2008	Phase 3 of NREGS

Table 2: Descriptive Statistics

	y_{TOT}	y_{CIV}	y_{INS}	y_{SP}	y_{EXP}	y_{FI}
Mean	123.6225	34.5049	70.2598	18.85784	10.5298	2.99
Std. Dev	116.1502	34.3978	71.1165	18.2096	11.6906	3.94
Skewness	1.1881	0.7268	1.8292	1.2211	1.5694	3.00
Kurtosis	4.5189	2.5820	7.6228	3.8229	5.9879	11.17
Maximum	621	150	432	81	64	22
Minimum	2	0	0	0	0	0
Observations	204	204	204	204	168	82

Notes: y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed, y_{EXP} denotes the incidents involving explosives, and y_{FI} foreign insurgents killed.

Table 3: Estimates of Smooth Transition Regressions

(a) Estimated Break Dates

Variable		***c***	**Break Date**
y_{TOT}		85.48***	February, 2005
	y_{INS}	84.32***	January, 2005
	y_{CIV}	87.94***	April, 2005
	y_{SP}	84.71***	January, 2005
y_{EXP}		65.61***	June, 2006

(b) Descriptive Statistics across Regimes

		High-Casualty Regime			Transition Phase			Low-Casualty Regime		
Variables		Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
y_{TOT}		253.5	621	103	148.6	316	44	25.2	82	2
	y_{INS}	77.3	150	36	39.4	92	0	2.8	11	0
	y_{CIV}	140.5	432	25	84.6	196	24	18.0	60	0
	y_{SP}	37.3	81	5	22.1	65	3	5.3	25	0
y_{EXP}		25.5	64	2	12.0	39	0	2.1	8	0

Notes: y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed and y_{EXP} denotes the incidents involving explosives. The optimal number of lags included in the model are one for civilians killed, insurgents killed and total killed, two for security personnel killed and one for incidents involving explosives. *, **, *** denote significance at 10%, 5% and 1% respectively.

Table 4: Estimates of Bai and Perron Multiple Structural Breaks

Series	Breakdate	Lower	Upper	Intercept	Trend
$\boldsymbol{y_{TOT}}$	2001:06	2000:12	2001:07	143	3.99
	2003:02	2003:01	2005:06	1213	-17.6
	2005:03	2004:11	2005:08	629	-6.15
	2006:11	2006:10	2007:07	620	-5.13
				114	-0.55
$\boldsymbol{y_{INS}}$	2001:05	2000:10	2001:06	58	2.65
	2003:03	2003:02	2004:08	819	-12.22
	2005:03	2005:01	2005:07	440	-4.57
	2007:03	2007:02	2008:03	411	-3.53
				81	-0.4
$\boldsymbol{y_{CIV}}$	1999:09	1999:07	2000:01	75	0.38
	2001:09	2001:08	2001:11	6	2.15
	2007:08	2007:07	2007:11	113	-0.83
				11	-0.05
$\boldsymbol{y_{SP}}$	2001:11	2001:10	2002:01	13	1.08
	2006:11	2006:10	2008:01	59	-0.44
				15	-0.06
$\boldsymbol{y_{EXP}}$	2002:08	2002:05	2003:01	35	-1.17
	2005:04	2004:12	2008:01	45	-0.70
	2007:08	2007:07	2008:04	34	-0.27
				6	-0.03
$\boldsymbol{y_{FI}}$	2005:03	2005:02	2007:01	60	-0.71
				5	-0.03

Notes: y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed, y_{EXP} denotes incidents involving explosives and y_{FI} denotes foreign insurgents killed. Shifting regressors are constant and a trend. The lower and upper columns denote 95% confidence intervals. The intercept and trend are the coefficient estimated for the regime prior that break. Number of breaks is determined by BIC with the maximum number of breaks set to 5 and the minimum length of the regime set to 20, except in the case of y_{FI} where the maximum number of breaks set to 3 and the minimum length of the regime set to 15 due the shorter time series.

Table 5: District-Panel Analysis

	Total killed	Total		
		Insurgents	Security personnel	Civilians†
	(1)	(2)	(3)	(4)
Border Fence	-0.866	-1.140*	-0.129	-2.158**
	(0.992)	(0.631)	(1.147)	(1.017)
Border Fence X Border Dist	0.938	2.099**	0.580	-0.547***
	(0.721)	(1.068)	(0.688)	(0.173)
NREGS	-0.164	-0.124	-0.942**	0.511**
	(0.391)	(0.339)	(0.435)	(0.231)
PMRP Expenditure	-0.002	-0.025***	-0.002	0.015**
	(0.006)	(0.009)	(0.007)	(0.007)
District FE	Yes	Yes	Yes	Yes
NREGS Phase FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2052	2052	1881	2052

Notes: This table reports estimates from the Poisson panel analysis discussed in the text. Standard errors clustered at the district level are reported in parentheses. In column 3 the district of Budgam is omitted from the analysis as there were no fatalities involving security personnel. * significant at 10%,** significant at 5%,*** significant at 1%.

† : Due to a highly singular variance matrix, standard errors reported in column 4 are not clustered.

Online Appendix for: Do Fences Make Good Neighbors? Evidence from an Insurgency in India

Kaila, Singhal, Tuteja

Figure A1: Map of Kashmir & Jammu

Notes: Grey dashed line is the de facto-border of India, including the Line of Control along the Pakistan border. Red dashed lines are the traditional boundaries. Grey solid lines denote district borders within India. Shapefiles used for Indian international and national boundaries are from DIVA-GIS database http://www.diva-gis.org/. Traditional boundaries are from QGIS sample file Natural Earth Quickstart Kit (https://www.qgistutorials.com/en/docs/credits.html).

A1 Additional Results on LSTR Models

A1.1 Unit root tests

Table A1: Lee-Strazicich Test for a Unit Root with Structural Breaks

Variable	Trend Break Model	Inference
$\boldsymbol{y_{TOT}}$	-7.1889***	I(0)
$\boldsymbol{y_{CIV}}$	-10.2589***	I(0)
$\boldsymbol{y_{INS}}$	-8.7762***	I(0)
$\boldsymbol{y_{SP}}$	-6.7783***	I(0)
$\boldsymbol{y_{EXP}}$	-6.069**	I(0)
$\boldsymbol{y_{FI}}$	-5.973**	I(0)

Notes: y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed and y_{EXP} denotes the incidents involving explosives and y_{FI} denotes foreign insurgents killed. Critical values are at the 1%, 5% and 10% levels, respectively.

A1.2 Nonlinearity tests

Table A2: Tests for Nonlinearity

Variable		Tsay (1986) Test Statistic	Luukkonen et al. (1988) Test Statistic
$\boldsymbol{y_{TOT}}$		5.59***	3.42***
	$\boldsymbol{y_{INS}}$	4.55***	4.26***
	$\boldsymbol{y_{CIV}}$	8.19***	5.43***
	$\boldsymbol{y_{SP}}$	6.10***	3.95***
$\boldsymbol{y_{EXP}}$		4.33***	2.96***

Notes: The Tsay test statistic test for threshold-type nonlinearity in the time series. The null hypothesis is is that the time series follows the SETAR model with one regime, while the alternative hypothesis is that the series follows a SETAR model with more than one regime, i.e depicting a non-linearity. Luukkonen et al. (1988) employ the Lagrange Multiplier approach for testing linear AR(p) models versus non-linear smooth transition autorgressive (STAR) models. y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed and y_{EXP} denotes the incidents involving explosives. *, **, *** denote significance at 10%, 5% and 1% respectively.

Table A3: Auxiliary Regressions to Test for Time as the Threshold Variable

Variable		**F-statistic**	**p-value**
$\boldsymbol{y_{TOT}}$		6.92	0
	$\boldsymbol{y_{INS}}$	5.08	0.002
	$\boldsymbol{y_{CIV}}$	29.32	0
	$\boldsymbol{y_{SP}}$	10.05	0
$\boldsymbol{y_{EXP}}$		7.95	0

Notes: y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed and y_{EXP} denotes the incidents involving explosives. The optimal number of lags included in the model are one for civilians killed, insurgents killed and total killed, two for security personnel killed and one for incidents involving explosives. *, **, *** denote significance at 10%, 5% and 1% respectively.

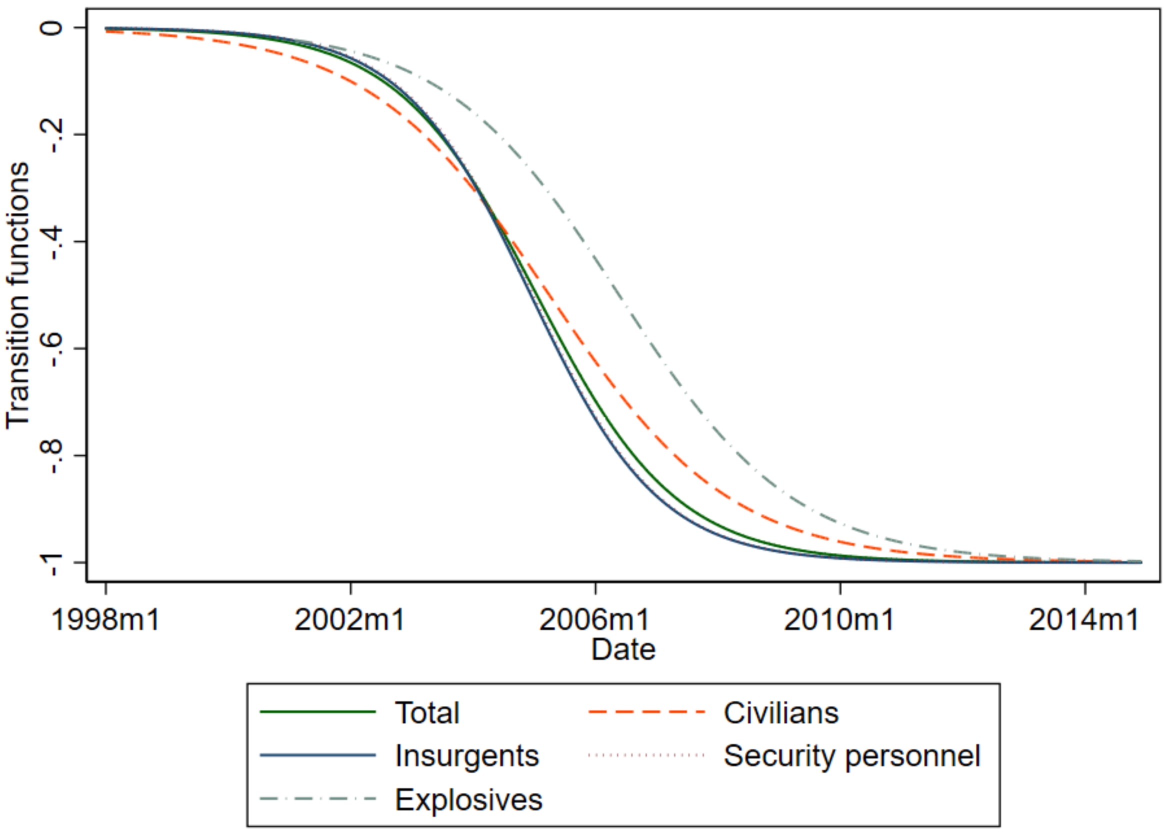
A1.3 LSTR Results in Full

Table A4: Estimates of LSTR model with time as the threshold variable

Variable	α_0	α_1	α_2	λ_0	$\boldsymbol{c}$	γ	**LB stat**
$\boldsymbol{y_{TOT}}$	58.044***	0.780***	-	-53.366***	85.477***	0.073*	4.212 (0.5193)
$\boldsymbol{y_{INS}}$	28.127***	0.810***	-	-25.279***	84.320***	0.079	2.029 (0.8451)
$\boldsymbol{y_{CIV}}$	58.220***	0.263***	-	-57.500***	87.940***	0.056***	2.236 (0.8156)
$\boldsymbol{y_{SP}}$	15.921***	0.456***	0.141**	-13.972***	84.71***	0.079*	6.189 (0.2882)
$\boldsymbol{y_{EXP}}$	14.310***	0.415***	-	-13.632***	65.609***	0.058**	10.368 (0.0655)

Notes: All parameter estimates for the LSTR model equation 2, of which the break dates are displayed in Table 3a. y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed and y_{SP} denotes the security personnel killed. The optimal number of lags included in the model are one for civilians killed, insurgents killed and total killed, two for security personnel killed and one for incidents involving explosives. *, **, *** denote significance at 10%, 5% and 1% respectively. Column LB stat in (b) denotes the Ljung-Box test statistic for autocorrelation in the residuals.

Figure A2: Transition Functions Estimated from the LSTR Model



A1.4 LSTR Results with Deseasonalized Data

Table A5: LSTR Model for the Transformed Data

(a) Estimated Break Dates

Variable		c	**Break Date**
y_{TOTD}		85.88***	March, 2005
	y_{INSD}	85.23***	February, 2005
	y_{CIVD}	88.21***	May, 2005
	y_{SPD}	84.82***	January, 2005
y_{EXPD}		65.61***	March, 2006

(b) Estimates of LSTR model with time as the threshold variable

Variable		α_0	α_1	α_2	λ_0	c	γ
y_{TOTD}		58.741***	0.789***	-	-50.253***	85.882***	0.074**
	y_{INSD}	27.549***	0.810***	-	-24.675***	85.236***	0,081
	y_{CIVD}	70.806***	0,103	-	-69.929***	88.205***	0.056***
	y_{SPD}	15.819***	0.384***	0.213***	-13.869***	84.824***	0.080**
y_{EXPD}		14.211***	0.444***	-	-13.619***	63.242***	0.053**

Note: y_{TOTD} denotes the total killed, y_{CIVD} denotes the civilians killed, y_{INSD} denotes the insurgents killed, y_{SPD} denotes the security personnel killed and y_{EXPD} denotes the incidents involving explosives using the deseasonalized data. The optimal number of lags included in the model are one for civilians killed, insurgents killed and total killed, two for security personnel killed and one for incidents involving explosives. *, **, *** denote significance at 10%, 5% and 1% respectively. Column LB stat in (b) denotes the Ljung-Box test statistic for autocorrelation in the residuals.

A1.5 Nonlinear Breaks in Transformed Data

As a robustness check, we transform our data using a linear mapping which preserves the order of the values. This is achieved by standardization of the time series by deducting the mean and dividing by the sample standard deviation For a series x_t, then, the transformed series will be given by $x_{tT} = \frac{x_t - mean}{standard\ deviation}$. In order to confirm the break dates, we redo the nonlinear analysis on the transformed data and estimate the LSTR model to detect the smooth breaks. The results are given in Table A6 below.

From Table A6 we find that the results for the transformed data are identical to those stated before. The break dates are correspondingly the same as before. This suggests that the break dates are robust.

Table A6: LSTR Model for the Transformed Data

(a) Estimated Break Dates

Variable		c	Break Date
y_{TOTT}		85.48***	February, 2005
	y_{INST}	84.32***	January, 2005
	y_{CIVT}	87.94***	April, 2005
	y_{SPT}	84.72***	January, 2005
y_{EXPT}		65.61***	June, 2006

(b) Estimates of LSTR model with time as the threshold variable

Variable		α_0	α_1	α_2	λ_0	c	γ
y_{TOTT}		0.266***	0.780***	-	-0.459***	85.478***	0.073*
	y_{INST}	0.209***	0.811***	-	-0.356 ***	84.320***	0.079
	y_{CIVT}	0.953***	0.263***	-	-1.672***	87.940***	0.056***
	y_{SPT}	0.457***	0.456***	0.141**	-0.768***	84.717***	0.079*
y_{EXPT}		0.697***	0.415***	-	-1.166***	65.609***	0.058**

Note: y_{TOTT} denotes the total killed, y_{CIVT} denotes the civilians killed, y_{INST} denotes the insurgents killed, y_{SPT} denotes the security personnel killed and y_{EXPT} denotes the incidents involving explosives using the transformed data. The optimal number of lags included in the model are one for civilians killed, insurgents killed and total killed, two for security personnel killed and one for incidents involving explosives. *, **, *** denote significance at 10%, 5% and 1% respectively. Column LB stat in (b) denotes the Ljung-Box test statistic for autocorrelation in the residuals.

A2 Bai & Perron Results with Exogenous AR-terms

Table A7: Estimates of Bai and Perron Multiple Structural Breaks (with exogenous AR terms)

Series		Breakdate	Lower	Upper	Intercept	Trend
$\boldsymbol{y_{TOT}}$		2001:06	2001:05	2001:07	150	5.89
		2003:02	2003:01	2003:05	1227	-16.12
		2005:03	2005:02	2005:05	751	-6.96
		2007:11	2007:10	2007:12	563	-4.18
					128	-0.6
	$\boldsymbol{y_{INS}}$	2001:05	2001:04	2001:06	46	3.38
		2003:03	2003:02	2003:06	680	-9.2
		2005:02	2005:01	2005:03	446	-4.47
		2006:10	2006:09	2006:11	332	-2.66
					90	-0.44
	$\boldsymbol{y_{CIV}}$	2001:04	2001:02	2001:05	98	0.14
		2003:02	2003:01	2003:12	265	-3.05
		2005:04	2004:11	2005:06	183	-1.54
		2007:04	2007:03	2007:06	213	-1.65
					20	-0.1
	$\boldsymbol{y_{SP}}$	2001:11	2001:10	2000:12	-14	3.6
		2006:07	2006:06	2006:09	137	-1.12
		2013:02	2013:01	2014:02	57	-0.31
					23	-0.07
$\boldsymbol{y_{EXP}}$		2003:08	2003:07	2003:10	37	0.52
		2006:02	2006:01	2006:04	55	-0.45
		2008:07	2008:06	2008:08	116	-1.18
					10	-0.04

Note: y_{TOT} denotes the total killed, y_{CIV} denotes the civilians killed, y_{INS} denotes the insurgents killed, y_{SP} denotes the security personnel killed and y_{EXP} denotes incidents involving explosives. Shifting regressors are constant and a trend. The lower and upper columns denote 95% confidence intervals. The intercept and trend are the coefficient estimated for the regime prior that break. Number of breaks is determined by BIC with the maximum number of breaks set to 5 and the minimum length of the regime set to 20. The AR structure is chosen by using AIC, BIC and HQ criteria. The number of exogenous AR-terms chosen are 8, 9, 12, 12 and 12 for the series Total killed, Insurgents, Civilians, Security Force Personnel, and Explosions, respectively.

A3 The Fence

Figure A3: The fence at the Line of Control (source: Rediff news)