9/11: What Did We Know and When Did We Know It?

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ABSTRACT

In February 1998, Osama Bin Laden published a signed statement calling for a fatwa against the United States for its having "declared war against God." As we now know, the fatwa resulted in the unprecedented attack of 9/11. The issue of whether or not 9/11 was in any way predictable culminated in the public debate between Richard Clarke, former CIA Director George Tenet and the White House. We examine whether there was any evidence of a structural change in the terrorism data at or after February 1998 but prior to June 2001, controlling for the possibility of other breaks in earlier periods. In doing so, we use the standard Bai-Perron procedure and our sequential importance sampling (SIS) Markov chain Monte Carlo (MCMC) method for identifying an unknown number of breaks at unknown dates. We conclude that sophisticated statistical time-series analysis would not have predicted 9/11.

Keywords: Terrorism, Structural Breaks, Markov Chain Monte Carlo, 9/11, Osama Bin Laden

JEL Classification Codes: C11, C52, C63, K42

Running Title: Predicting 9/11

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INTRODUCTION

The events of 9/11 were unparalleled in that damages are estimated to be in excess of $90 billion and the number of people killed was as great as that from all transnational terrorism for 1988-2000 (Sandler, 2003). According to the National Commission on Terrorist Attacks Upon the United States (2004) Report (known as the *The 9/11 Commission Report*), all al-Qaida attacks prior to 9/11 (including the simultaneous attacks on the US embassies in Tanzania and Kenya and the attack on the *USS Cole*) killed fewer than 50 Americans.

Accused of ignoring the al-Qaida threat, the White House repeatedly asserted that the 9/11 attack was "historical" in nature and that it had little reason to suspect an attack on US soil. However, in February 1998, Osama Bin Laden published a signed statement calling for a fatwa against the United States for its having "declared war against God."[1] Bin Laden and the other signatories of the statement claimed that the duty of every Muslim was to murder any American anywhere on earth. Three months later, in an interview on the ABC television network, Bin Laden stated: "We believe that the worst thieves in the world today and the worst terrorists are the Americans. Nothing could stop you except perhaps retaliation in kind. We do not have to differentiate between military and civilian."

The issue of whether or not 9/11 was in any way predictable culminated in the public debate between Richard Clarke and the White House that played out in front of the 9/11 Commission. Richard Clarke, the former head of US counterterrorism, charged that the Bush administration had ignored an urgent al-Qaida threat because it was fixated on Iraq. Former CIA Director George Tenet provided extra ammunition when he testified that more could have been done to foil the September 11 attacks. "We didn't integrate all the data we had properly, and probably we had a lot of data that we didn't know about that if everybody'd known about maybe we would have had a chance. I can't predict to you one way or another."

To counter these charges, Secretary of State Colin Powell told German television that the Bush administration "did as much as we could, knowing what we knew about the situation." Condoleezza Rice, the president's national security adviser, described a series of steps the White House had taken to put the nation on heightened terrorism alert. Among the steps that Rice mentioned, "all 56 FBI field offices were also tasked in late June to go to increased surveillance and contact with informants related to known or suspected terrorists in the United States."

Nevertheless, prior to 9/11, terrorist experts warned that religion-based terrorists viewed nonbelievers as legitimate targets and sought to inflict increased levels of violence against the West (Hoffman, 1998). Enders and Sandler (2000) document that increases in religion-based terrorism and the lethality of terrorist incidents coincided with the takeover of the US embassy in Tehran in November 1979. The aim of this paper is to determine whether there is any evidence to suggest a change in the nature of terrorist activities associated with Bin Laden's renewed call for terrorist activities directed against the United States. This issue is complicated by the fact that there are good reasons to suppose that the time-series variables measuring the extent of transnational terrorism have probably undergone a number of structural breaks. The number of breaks is unclear and the date at which each break manifests itself is unknown.

We use two different statistical methods to identify the potential structural breaks. The well-known Bai-Perron (1998, 2003) test uses maximum likelihood methods to estimate a regression (or autoregression) allowing for an unknown number of endogenous breaks. At the time of this writing, Google Scholar lists 200 citations for Bai-Perron (1998) and 69 citations for Bai-Perron (2003). However, our use of the Bai-Perron procedure might be problematic since it assumes normality.[2] The transnational terrorism series are counts that are sufficiently thin to be properly modeled as a Poisson process. As such, we complement the Bai-Perron results by comparing them with a method based on sequential importance sampling (SIS) in conjunction with Markov chain Monte Carlo (MCMC) simulation. Although not heavily used in the standard economics literature, the SIS-MCMC approach allows us to estimate the various terrorism time-series variables based on Poisson processes. Since the approach is essentially Bayesian, we are able to obtain posterior samples for the potential break dates. We show that the two methods yield quite different results concerning breaks in the early portion of the sample; however, neither procedure identifies breaks that would signal a significant change in attacks immediately prior to 9/11.

BACKGROUND

Enders and Sandler (2006) define *terrorism* as the premeditated use or threat of use of violence by individuals or subnational groups to obtain a political or social objective through the intimidation of a large audience, beyond that of the immediate victims.[3] The distinguishing element between an ordinary crime and a terrorist event is the presence of a political or social motive. A murder for personal revenge is a criminal act, while a politically motivated assassination is a terrorist act. Domestic terrorism begins and ends in the host country and the perpetrators and targets are of the same nationality. Moreover, domestic incidents have ramifications for only the host country. When a terrorist incident in one country involves victims, targets, institutions, or citizens of another country, terrorism assumes a *transnational* character.

A brief history of the modern era of transnational terrorism suggests a number of possible break dates. Hoffman (1998) and Enders and Sandler (2006) indicate that the modern era began in 1968 following the Arab-Israeli conflict and Israel's subsequent occupation of captured territory. Without any legal means to settle their grievances, the Palestinians resorted to international terrorism to publicize their cause to the global community and gain recognition by the Israelis. The level of transnational terrorism reached a new plateau in the mid-1970s as Palestinian frustration achieved new heights and their terrorist methods were copied by various ethno-nationalist movements and by left-wing groups throughout much of Western Europe (Alexander and Pluchinsky, 1992).

As discussed in Hoffman (1998) and Enders and Sandler (2000), the November 1979 takeover of the US embassy in Tehran marked a jump in the use of religion-based terrorism. Another potential structural break is anticipated in the early 1990s following the end of the Cold War, when many of the left-wing terrorist groups in Europe either ended their operations or were brought to justice (Alexander and Pluchinsky, 1992; Chalk, 1996). Part of the decline can be attributed to a reduced interest in Marxism following the collapse of the Soviet Bloc. At the same time, there was less state sponsorship of leftist terrorists by East European and Middle Eastern countries (Chalk, 1996; Clutterbuck, 1990). The early 1990s also saw the rising influence of fundamentalist terrorism, so that a greater number of casualties is expected to characterize the anticipated reduced level of terrorism. The key point is that the precise break dates are unknown since the rise in fundamentalism was not instantaneous and the Cold War did not end in any single month. Moreover, the total number of breaks is unclear since events in the Israeli-Palestinian region, Northern Ireland, Latin America and other Middle Eastern countries might all induce breaks in the terrorism series.

DATA

Data on transnational terrorist incidents are drawn from *International Terrorism: Attributes of Terrorist Events* (ITERATE) (Mickolus *et al*., 2004). ITERATE relies on the world's news print and electronic media for its information with a large reliance on the Foreign Broadcast Information Service's (FBIS) *Daily Reports*, which covers several hundred of the world's newspapers and related news sources. For each transnational terrorist incident, ITERATE records the incident's date, location, type (e.g., bombing or hostage event), number of people killed, number of people wounded, and the presence of a US target. ITERATE excludes terrorist incidents associated with declared wars or major military interventions and guerrilla attacks on military targets of an occupying force. Even though ITERATE records events on a daily basis, we used monthly totals to avoid periods with many zero or near-zero observations. Although ITERATE runs from January 1968 through the end of 2003, we use only the data through June 2001. After all, the 1968:01 – 2001:06 subsample is all that government researchers would have had available for analysis prior to the 9/11 attacks.

[Figure 1 near here]

We extract three primary time series for our structural analysis. The ALL series, shown in Figure 1, comprises the monthly totals of all types of transnational terrorist incidents with a US target. We are interested in those incidents with US targets (persons or property), because these specific incidents would better signal than all incidents a large-scale US offensive in advance of 9/11. Since some incidents can have more serious ramifications than others, we also construct the monthly totals of all transnational terrorist attacks in which there is a US casualty (CAS) and all transnational deadly bombings (Bomb) against a US target. Respectively, the CAS and Bomb series are shown in Figures 2 and 3 below. Notice that all of the series are counts and that CAS and Bomb are both quite thin. It would have been interesting to further disaggregate the series into state-sponsored attacks, attacks by leftists, and religion-based attacks. However, for most instances in ITERATE, the perpetrator is not reported with certainty so such a disaggregation is not possible.

[Figures 2 and 3 near here]

FINDING BREAKS USING THE BAI-PERRON PROCEDURE

The Bai-Perron (1998, 2003) procedure is a purely data-driven methodology allowing the researcher to estimate multiple structural breaks when the number of breaks and the break dates are unknown. Bai and Perron (1998) derive the limiting distribution of the test for the null hypothesis of no breaks against the alternative hypothesis of an arbitrary number of breaks. To pin down the number of breaks, it is also possible to test for n breaks against the alternative of $n + 1$ breaks. For our purposes, the key feature of the procedure is that we can use it to obtain point estimates of the break dates and to form confidence intervals around the estimated dates. As such, we can determine whether there is a statistically significant break date such that a 95% confidence interval contains February 1998.

The procedure requires that we specify the minimum regime size (i.e., the minimum number of observations between breaks) and the maximum number of permissible breaks. Because our data runs through June 2001, we used a minimum regime size of 5 months to permit a break occurring as late as January 2001. We also allow for no more than 5 breaks and control for possible time dependence in the series by estimating each as an autoregressive process. Let x_t denote the number of terrorist incidents of a particular type occurring at time period t and consider the simple AR(p) specification:

$$x_t = a_0^j + \sum_{i=1}^{p} a_i^j x_{t-i} + \varepsilon_t, \qquad (1)$$

where $j = 0, \ldots, K$ and K is the number of breaks. Equation (1) allows for K breaks that manifest themselves by shifts in the intercept and autoregressive coefficients. Our notation is such that in each regime j, the coefficients of the process are a_i^j ($i = 0, \ldots, p$). The first break occurs at c_1 so that the duration of the first regime is from $t = 1$ until $t = c_1 - 1$ and the duration of the second regime is from c_1 to $c_2 - 1$. Because the K-th break occurs at $t = c_K$, the last regime begins at c_K and lasts until the end of the data set.

[Table I near here]

For each series, Table I reports the overall means along with the various subsample means obtained by using the break dates selected by the sequential method and also by the Bayesian Information Criterion (BIC) method.[4] Table I also lists the point estimate for each break date along with the lower and upper bounds of a 95% confidence interval around each starting break date (Lower and Upper, respectively). For example, over the entire period, the mean number of monthly attacks with a US target is 9.86 incidents. The Bai-Perron sequential method selects two break dates so that there are three distinct regimes. In the first regime, the number of attacks is 11.72 incidents per month. The most likely estimate of the first break is 1991:02; a 95% confidence interval spans the period 1989:12 to 1992:10. In this second regime, the mean number of monthly incidents falls to 6.08 until 1999:09. This second break lies within a 95% confidence interval spanning 1999:07 through the end of the sample. The mean number of incidents in the final regime is only 4.14 attacks per month. The BIC selects only 1991:02 as the break date.

However, as shown in Table I, the CAS series does not experience a significant break after 1994:02, and the bombing series does not experience a significant break after 1973:11. The key point is that from the perspective of June 2001, it might have been possible to observe a significant change in the number of attacks against US interests. Osama Bin Laden's proclamations against the United States in February and May of 1998 occurred prior to a statistically significant break in the ALL series. However, 1999:09 is associated with a decrease in the number of attacks against U.S. interests. As such, it would be hard to interpret this break as the beginning of a new wave of terror directed against the United States.

FINDING BREAKS USING THE SIS-MCMC SIMULATION

As should be clear from Figures 1 to 3, it seems plausible to model each of the various terrorism series as a Poisson distribution since these series possess low frequent count data. When there are K breakpoints, we have to consider $(K+1)$ Poisson distributions with $(K+1)$ Poisson parameters as well as the locations of K breakpoints. Our methodology is based on sequential importance sampling (SIS), which is a combination of importance sampling (Marshall, 1956) and sequential sampling. We use the SIS strategy in conjunction with Markov chain Monte Carlo (MCMC) simulation. The idea of our method is straightforward:

Step 1: We first select K ($K = 1, \ldots, 5$) potential breakpoints by randomly selecting K possible values for the breakdates. We then generate a second set of candidate breakpoints and select the set that best fits the data. We repeat this process 500 times in order to get a well-fitting selection of breaks.[5]

Step 2: We repeat Step 1 a total 1,000 times in order to obtain 1,000 sets of well-fitting breaks for the given value of *K*. We use these 1,000 sets of breaks to form a posterior distribution of breaks.

Step 3: We obtain the best value of *K* by comparing the results from Step 2. In order to be consistent with the Bai-Perron procedure, we used the BIC as a goodness-of-fit measure. Specifically, we computed the BIC for each *K* using the posterior modes of sampled breakpoints and the posterior means of sampled Poisson parameters as in Wang and Zivot (2000).[6,7]

As in the Bai-Perron test, we assume that there are at least 5 months between two consecutive breakpoints and consider no more than 5 breaks. Nevertheless, in the Bayesian tradition, the BIC alone cannot be a perfect criterion for the model selection problem. After all, investigating the entire posterior samples might reveal some important facts that simple point estimation and hypothesis testing might ignore or miss. Hence, to take advantage of the obtained posterior distribution, we use the histogram of posterior breakpoints in addition to the BIC to do the final decision for the number of breakpoints.

MCMC RESULTS

The BIC selects two breakpoints for all three series.[8] The details containing the nature of the breaks are contained in Table II. The histograms of posterior breakpoints from 1,000 independent MCMC chains based on two breakpoints for All, CAS and Bomb are shown in Figures 4, 5, and 6, respectively. The vertical axis in each figure is the number of instances (out of the 1000 chains) that a particular breakpoint was selected. For example, in Figure 4, April 1991 was selected as a breakpoint a total of 179 times.

[Table II and Figure 4 near here]

If we use the peaks of the histograms to indicate the most likely break dates, Figure 4 shows that for the ALL series, the two most likely break dates occur at 1969:06 and 1991:04. Although the BIC indicates only two breaks, the histogram indicates the possibility of a third break at 1999:12. Prior to the first break, the mean number of monthly incidents is 4.35. The mean number of incidents is 12.32 between 1969:06 and 1991:03 and is 5.83 between 1991:04 and 1999:11. If we are willing to accept the existence of a break at 1999:12, it could be concluded that there was a fall in the number of incidents (to a mean of 2.95 incidents per month) before 9/11. Notice that these SIS-MCMC results are very similar to those of the Bai-Perron procedure. Both methods find a break in the early 1990s. Enders and Sandler (2000) argue that this break corresponds to a decrease in terrorism associated with the demise of the Soviet Union. It is especially interesting to note that neither method finds a break that corresponds to the month prior to the takeover of the U.S. embassy in Tehran (1979:10). Enders and Sandler (2000) use a Chow-type test and argue that such a break is associated with an increase in religion-based terrorism.

The SIS-MCMC method does find a break in 1969 and the Bai-Perron method finds more evidence of a break in 1999. However, the similarity of the results should not be too surprising since the ALL series is relatively thick. As such, the use of a Poisson model versus a model assuming normality should not provide very different results.

[Figure 5 near here]

The histogram for the CAS series is shown in Figure 5. The two most likely breakpoints (as selected by the BIC) are not as clear as those for the ALL series. This would be the case if the breaks are not sharp and/or manifest themselves slowly. The most likely break occurs in

1994:05 and the second most likely in 1974:04. Notice that these are almost precisely the break dates selected in the sequential method using the Bai-Perron procedure.

The histogram for deadly bombings, shown in Figure 6, indicates clear breaks occurring in 1974:04 and 1997:04. The mean of Bomb is 1.09 incidents per month prior to 1974:04, 2.89 during the 1974:04 – 1997:03 period, and 1.51 during the final period.

[Figure 6 near here]

CONCLUSIONS

A key issue in the paper is to determine whether the time-series methodologies can identify a break in the number of terrorist incidents corresponding to Bin Laden's proclamation in 1998. If the sequential procedure is used, the Bai-Perron procedure finds a break in the ALL series at 1999:09 that corresponds to a fall in the number of incidents from 6.08 to 4.14 incidents per month. Our SIS-MCMC method finds a decrease in ALL incidents at 1999:12 from 5.83 to 2.95 incidents per month. Since the number of incidents actually fell prior to 9/11, the antiterrorism authorities might have been hard-pressed to suspect an attack of the magnitude of 9/11. Moreover, there was not a consequent change in the CAS or Bomb series. One possible explanation for these results comes from Enders and Sandler's (2005) empirical finding that terrorist campaigns are cyclical in nature. Terrorists deplete their resources and replenish them in low-terrorism periods. The level of violence remains low while the terrorists replenish their resources and plan subsequent attacks. It could have been that the terrorists cut back on non-serious incidents (so that ALL fell while CAS and Bomb were unchanged) in order to prepare for 9/11. We also showed that the SIS-MCMC method can be quite useful. For example, the SIS-MCMC findings of breaks in the ALL and CAS series near mid-1996 have not been previously identified in the literature.

It is important to note that our findings are all based on univariate statistical analysis. In principle, it would have been possible for us to incorporate explanatory variables into the Bai-Perron and MCMC methods. However, it is not clear what variables should have been included since the choice needs to be made without the benefit of 20-20 hindsight. Another limitation of our results is that breaks are necessarily modeled as sharp changes rather than smooth changes in the mean of each series. If, as discussed in Enders and Sandler (2002), structural changes manifest themselves slowly, the methods used here might not be able to detect any breaks. Nevertheless, we must conclude that statistical analysis using only publicly available data would not have signaled the coming of 9/11. Intelligence about students in flight training, chatter on the web, and the entry to the United States of people on a watch list could have signaled 9/11. In this case, intelligence would have outperformed elegant statistical analysis. This is an interesting policy insight since the creation of a new counterterrorism center is intended, in part, to perform the type of sophisticated analysis of this paper to predict coming terrorist offensives. As such, it is worthwhile to reconsider the Defense Advanced Research Projects Agency's (DARPA) proposed web-based futures market for terrorist activities. The idea was that economic agents could buy or sell futures against the likelihood of an ensuing terrorist attack. The so-called Futures Markets Applied to Prediction (FutureMAP) program was never implemented since the public's outcry against anyone profiting from a terrorist attack was overwhelming. There were also moral hazard concerns since a group of individuals might decide to stage a terrorist attack in order collect on its futures contracts. Nevertheless, any sharp increases in the demand for terrorism futures not attributable to publicly available information would likely be the result of insider information. In addition to allowing non-insiders to insure themselves against terrorism risk, FutureMAP would have served as a signal of an impending terrorist attack. This trading on inside information could have bolstered standard sources of intelligence.

Footnotes

*Corresponding author: E-mail:wenders@cba.ua.edu. Lee is an Assistant Professor of Mathematics; Enders holds the Bidgood Chair of Economics and Finance; and Sandler is the Vibhooti Shukla Professor of Economics and Political Economy. We acknowledge helpful comments from an anonymous referee and John Warner. Any remaining shortcomings are those of the authors.

1. All quotations in this paragraph use the translations from *The 9/11 Commission Report* (2004).

2. In principle, it is possible to modify the Bai-Perron procedure so as to use any probability distribution. To our knowledge, no one has attempted to extend the method in this direction.

3. Hoffman (1998) and Enders and Sandler (2006) each contain extended discussions of several alternative definitions of terrorism.

4. The procedure can identify breaks sequentially (i.e., no breaks versus one break, one break versus two breaks) or globally. The global method uses the BIC to select the 'best' combination of break dates. We also use the nonparametric method to control for dependence, but the results are similar to those reported in Table I. Specifically, instead of using the lagged values of x_{t-i} in equation (1), we searched for breaks in the means of the various series. In essence, we estimated the most likely break dates for the model $x_t = \alpha_0^j + e_t$. Since the residuals, e_t, are serially correlated, inference is conducted using the robust standard errors as described in Bai and Perron (1998, 2003).

5. We use a straightforward SIS strategy in generating and comparing breakpoints. We simply compare the breakpoint of the current MCMC iteration with a new candidate breakpoint,

conditioning on the two current surrounding breakpoints. Since SIS decomposes the complicated target function into several pieces of manageable forms, we can easily use SIS in generating a candidate breakpoint and corresponding Poisson parameters. Then, we accept or reject the new candidate against the current values using the acceptance probability built by SIS.

6. We also use AR(1) model with a normal error term as in Bai-Perron for the SIS-MCMC, but the result is less informative in the sense that it provides smaller numbers of breakpoints and almost all breakpoints are found in the result of the Poisson model.

7. Liu (2001) contains an excellent discussion of the SIS and Monte Carlo strategies. A general explanation about Bayesian statistical methods including MCMC can be found in Gelman, Carlin, Stern, and Rubin (1995).

8. The histograms from the models of other numbers of breakpoints do not show any additional obvious breakpoints, or just show too many insignificant breakpoints. The other histograms are not provided in this paper.

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Table I Breakpoints Identified by the Bai-Perron Procedure

Series	*Estimation Method*	*Start Date*	*End Date*	*95% Lower Bound*	*95% Upper Bound*	*Period Mean*	*Overall Mean*
ALL							9.86
	Sequential	---	1991:01			11.72	
		1991:02	1999:08	1989:12	1992:10	6.08	
		1999:09	---	1999:07	---	4.14	
	BIC	---	1991:01			11.72	
		1991:02	---	1989:12	1992:10	5.74	
CAS							1.95
	Sequential	---	1974:01			1.41	
		1974:02	1994:01	1971:02	1976:12	2.42	
		1994:02	---	1993:04	1995:05	1.13	
	BIC	---	1994:01			2.18	
		1994:02	---	1993:04	1995:05	1.13	
Bomb							2.38
	Sequential	---	1973:10			1.07	
		1973:11	---	1973:01	1974:05	2.66	

Table II Breakpoints Identified by SIS-MCMC

Series	*Start Date*	*End Date*	*Period Mean*	*Overall Mean*
ALL				9.86
	---	1969:05	4.35	
	1969:06	1991:03	12.32	
	1991:04	1999:11	5.83	
	1999:12	---	2.95	
CAS				1.95
	---	1969:06	0.72	
	1969:07	1973:12	1.67	
	1974:01	1994:04	2.42	
	1994:05	1996:06	1.38	
	1996:07	---	0.92	
Bomb				2.38
	---	1974:03	1.09	
	1974:04	1997:03	2.89	
	1997:04	---	1.51	

Figure Captions

FIGURE 1: All incidents with US targets

FIGURE 2: US casualty incidents

FIGURE 3: Deadly bombings with US targets

FIGURE 4: Histogram for all incidents with US targets

FIGURE 5: Histogram for US casualty incidents

FIGURE 6: Histogram for deadly bombings with US targets

Figure 1: All incidents with US targets

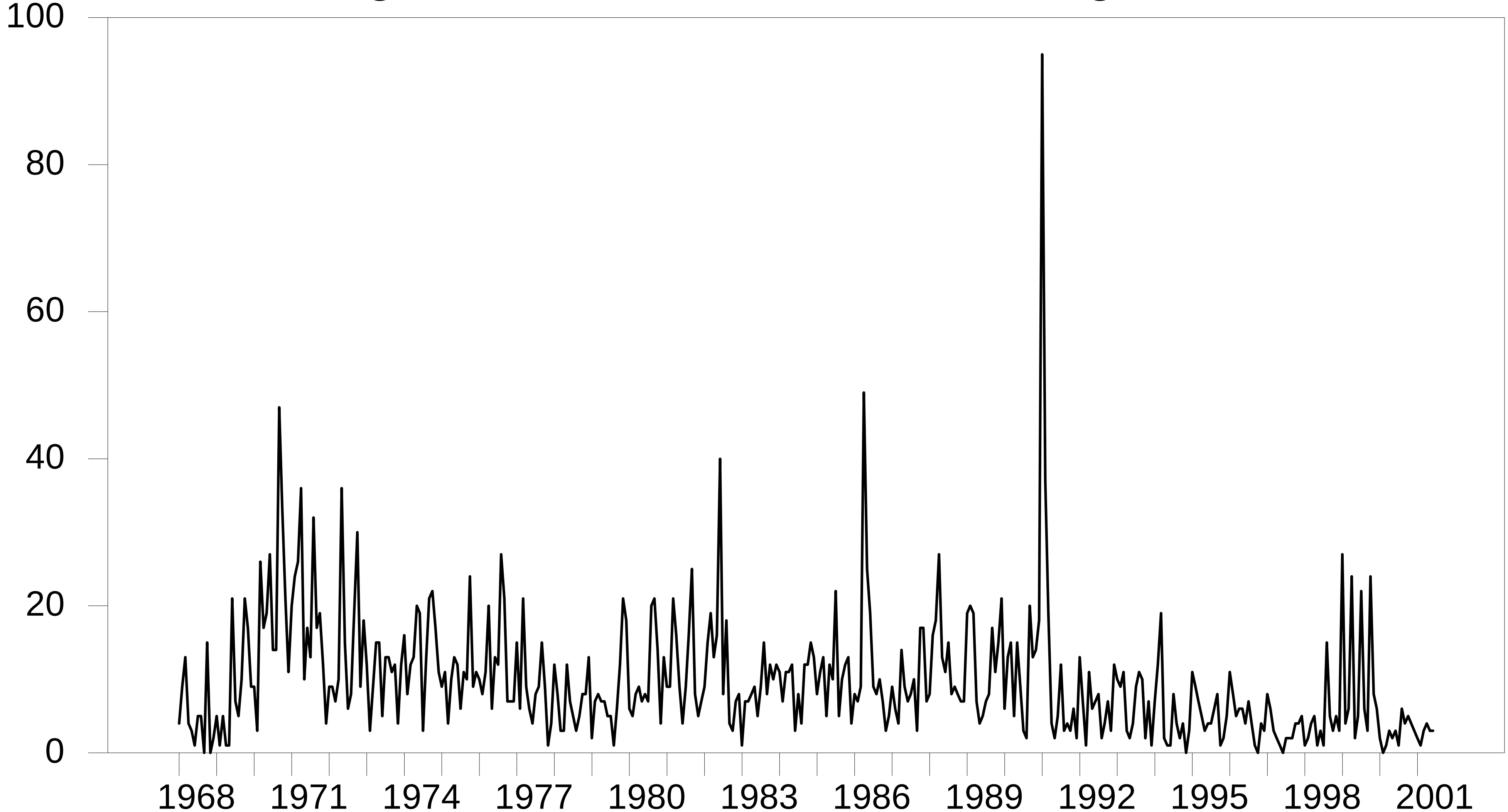

Figure 2: US casualty incidents

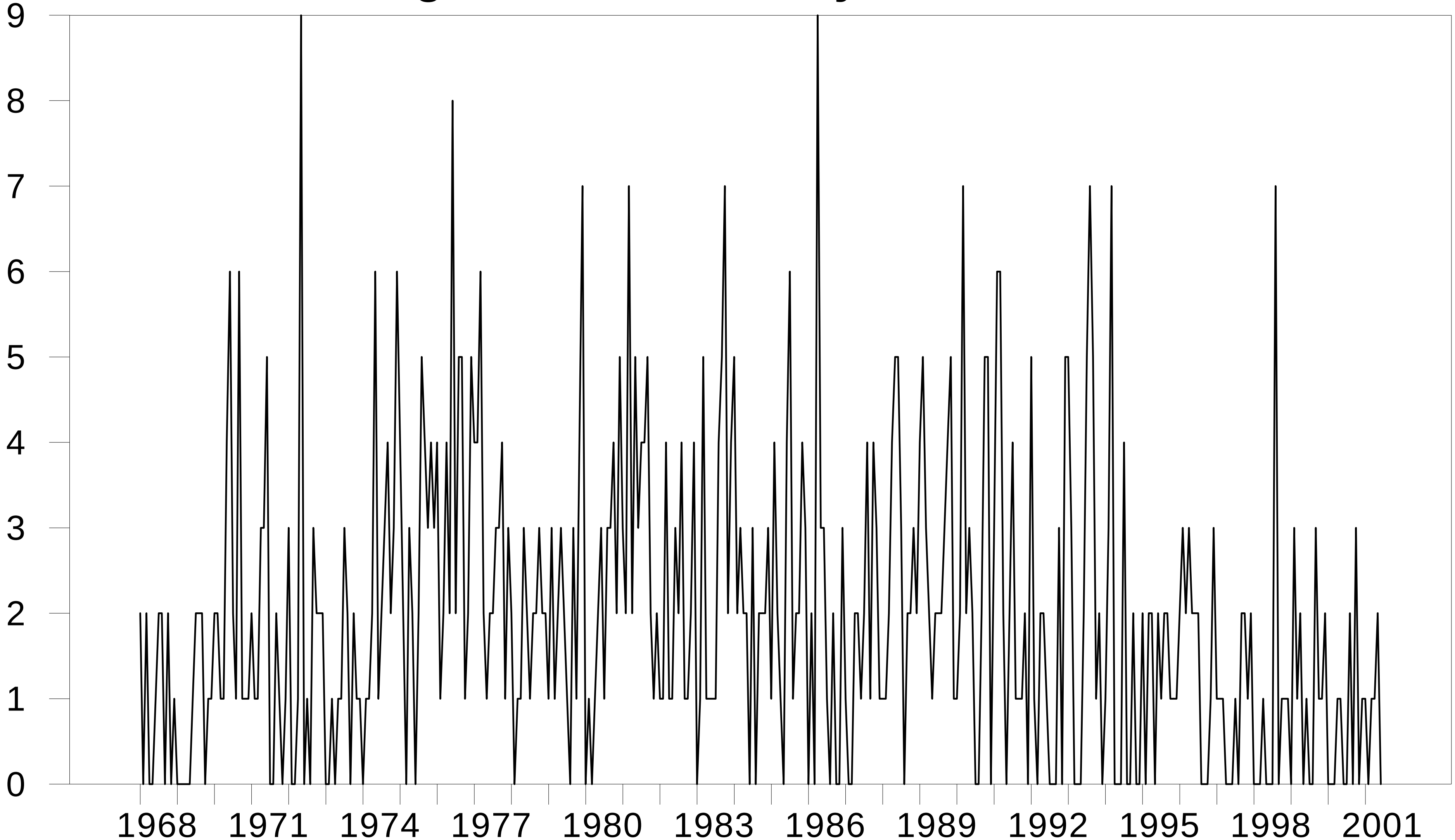

Figure 3: Deadly bombings with US targets

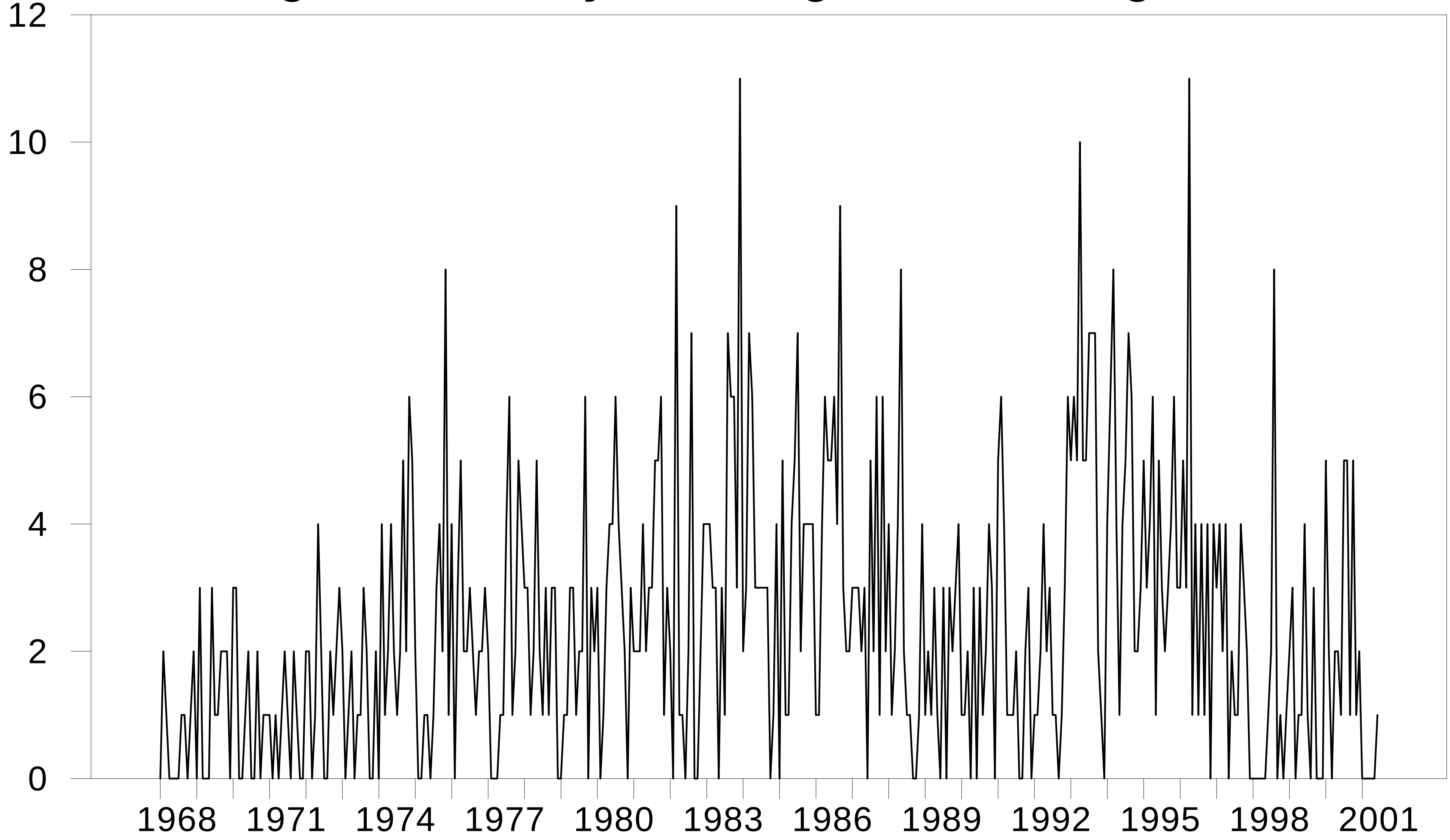

Figure 4: Histogram for all incidents with US targets

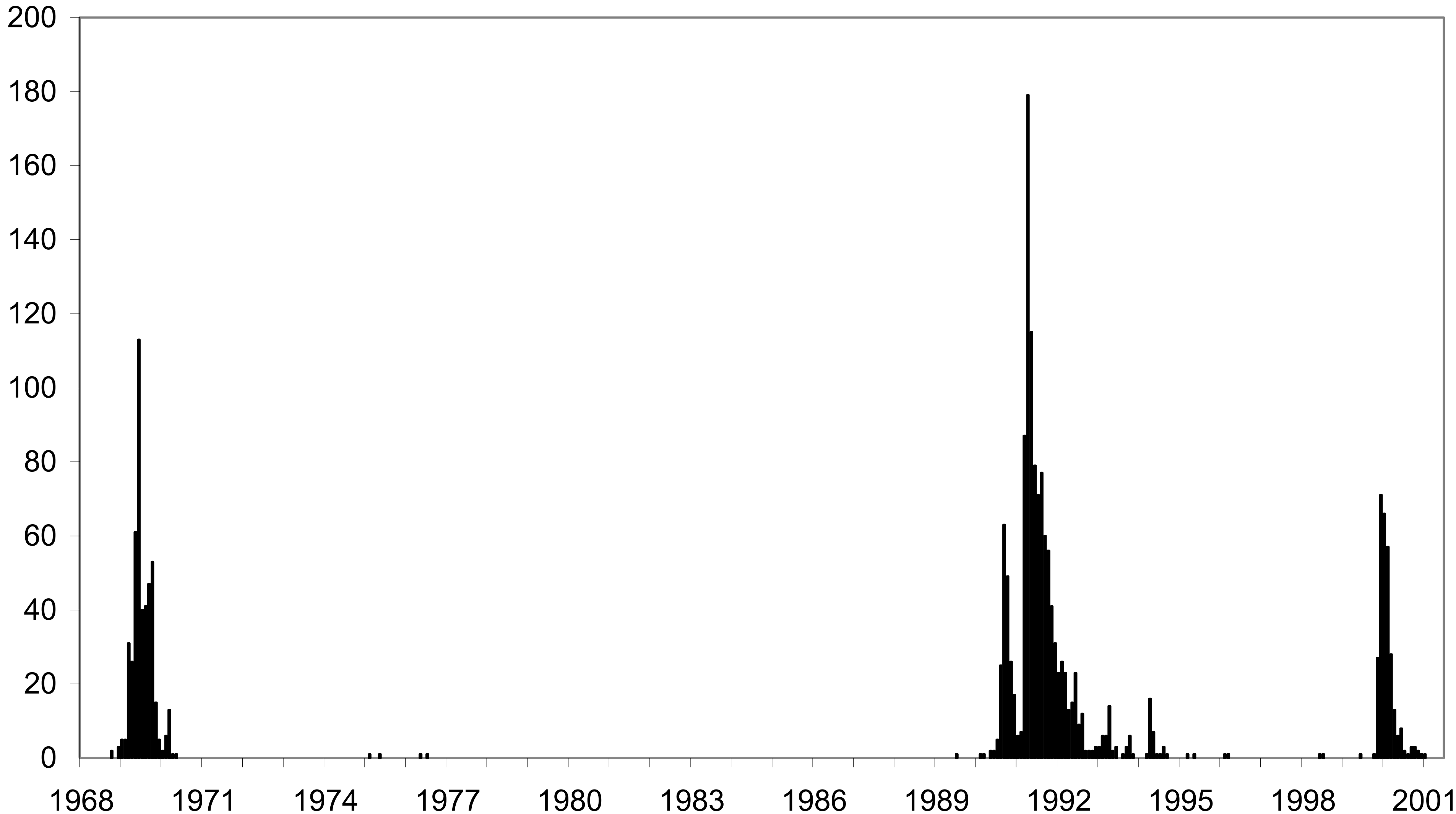

Figure 5: Histogram for US casualty incidents

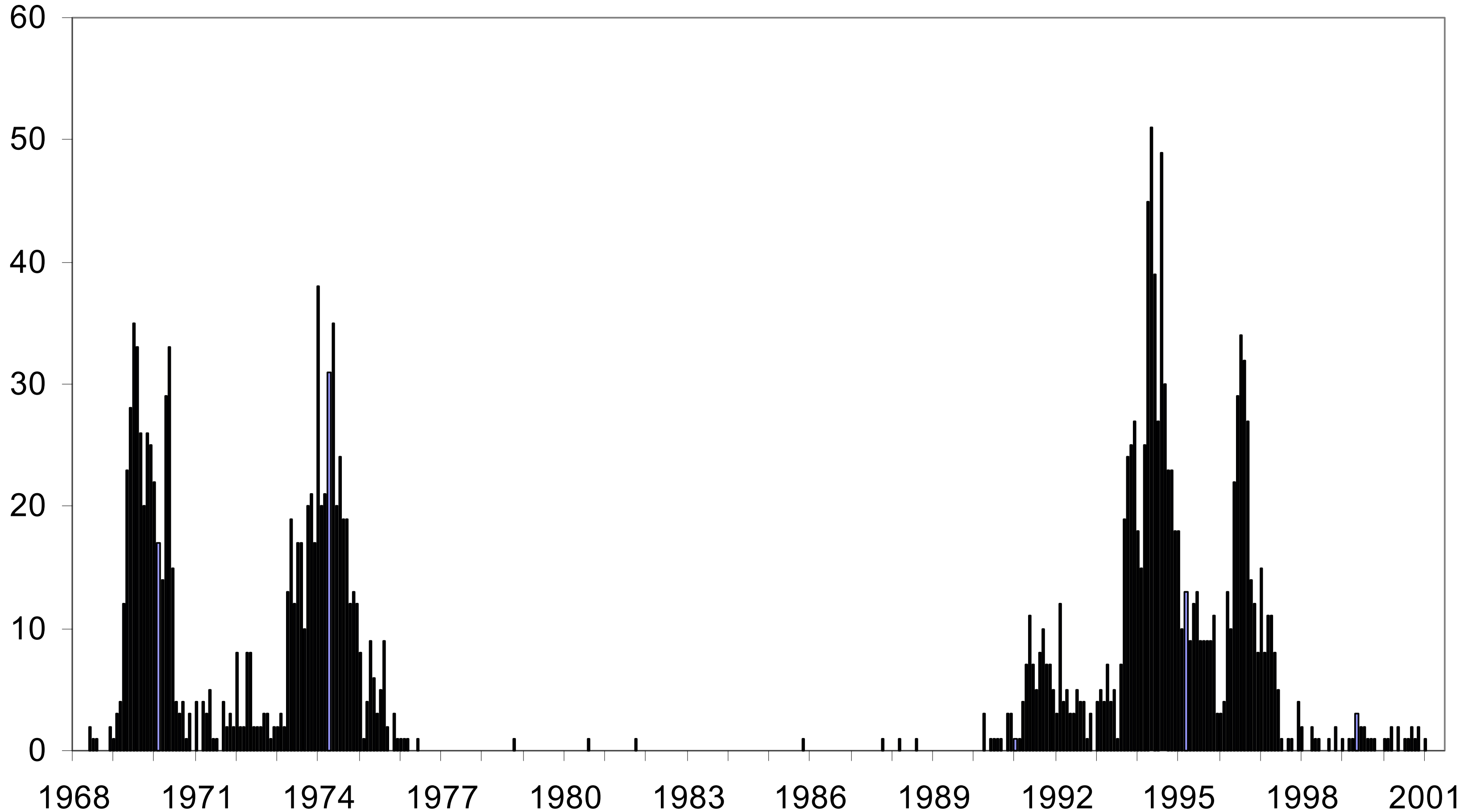

Figure 6: Histogram for deadly bombings with US targets