# Terrorist attack and target diversity: Changepoints and their drivers

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Abstract

Terrorists choose from a wide variety of targets and attack methods. Unlike past literature, this article investigates how diversity in target choice and attack modes among domestic and transnational terrorists has evolved and changed over the past 40 years. Changes in the practice of homeland security, which affects the marginal costs of target-attack combinations, and changes in the dominant terrorist influence at the global level, which affects the marginal benefits of target-attack combinations, drive the changepoints. Our empirical analysis relies on count data drawn from the Global Terrorism Database (GTD) for 1970–2010 that distinguishes between domestic and transnational terrorist incidents. Given the data-intensity requirements of our methods, the study is necessarily from a global perspective. A Bayesian Reversible Jump Markov chain Monte Carlo (RJMCMC) changepoint analysis is applied to identify arrival rate changes in both domestic and transnational terrorism. The changepoints in these aggregate series are then matched with those of the subset time series for attack modes (e.g., assassinations and bombings) and target types (e.g., officials and private parties). The underlying drivers of these changepoints are then identified. The article also calculates a Herfindahl index of attack diversity for the aggregate and component domestic and transnational terrorism time series for the entire period and during four subperiods. The variation in both domestic and transnational terrorist attacks has generally fallen over the last four decades; nevertheless, this diversity still remains high. Bombings of private parties have become the preferred target-attack combination for both transnational and domestic terrorists. This combination is the hardest-to-defend target-attack combination and requires the most homeland security resources. Policymakers can use these and other results to focus their counterterrorism measure.

*Keywords*: Counterterrorism, Domestic and transnational terrorism, Diversity of attacks and targets, Bayesian multiple changepoints

**Introduction**

Today, governments must deal with domestic terrorism within their country's borders and transnational terrorism within and outside their country's borders. Domestic terrorism is home-directed and homegrown involving victims, perpetrators, and target venues from a single country; transnational terrorism is a multi-country affair involving victims, perpetrators, or target venues from two or more countries. Counterterrorism measures are implemented to secure against diverse terrorist attack modes (e.g., bombings and kidnappings) and to protect alternative targets (i.e., government officials, businesses, military, and private parties).

Terrorist diversity of attacks and targets raises several unanswered questions. Do domestic and transnational terrorists favor the same targets and use the same campaign strategies when seeking political change? Do domestic and transnational terrorists use greater or lesser variation in choosing whom and how to attack – i.e., the target-attack combination? How have changes in homeland security and the changing dominance of terrorist types influenced attack modes and target choice?

The primary purpose of this article is to answer these questions from a global perspective. We do so through the use of a Bayesian Reversible Jump Markov chain Monte Carlo (RJMCMC) changepoint analysis to identify global shifts in both domestic and transnational terrorism. We find and match these changepoints with those of attack modes and target types. By so doing, we gain a better understanding of the drivers of both domestic and transnational terrorism. We take a global viewpoint for two reasons: (i) our empirical method requires data-rich time series, only available at the global level; and (ii) we are interested in how changes in counterterrorism and the dominant terrorist influence affect terrorism worldwide. Next, we employ a Herfindahl index of diversity to determine the degrees of attack and target diversification associated with the two types of terrorism. We discover both good and bad news.

In recent years, the diversification in target choice and attack mode for both types of terrorists has fallen. This suggests that counterterrorism measures are working and terrorists are losing substitution ability among choices. However, the level of diversification is still high, which means that counterterrorism measures must focus on deterring many types of attack modes and protecting most kinds of targets. This is still a costly prospect. However, costs can be curtailed if counterterrorism measures are directed toward the preferred attack and target combinations used by transnational and domestic terrorists. This counterterrorism strategy will be particularly effective if the more damaging target-attack combinations are deterred, so that terrorists resort to less harmful incidents. Past actions have not necessarily achieved this goal. We also find that domestic terrorists are more diverse than transnational terrorists in their use of attack modes when hostage events are excluded. Both types of terrorists use almost equally high levels of diversification among target types.

A secondary purpose is to investigate the past, present, and future of terrorists' target and attack choices using the same techniques. From a global viewpoint, we analyze how terrorists' target-attack choices have evolved over time, what their current state is, and what this implies for the future. For both domestic and transnational terrorist groups, we find that private parties are now the most favored targets and bombings are the most favored attack mode. This is an unfortunate outcome because bombings of civilians are the most difficult target-attack combination to defend against. We believe that this trend will continue into the future.

Our final purpose is to draw policy conclusions that will help policymakers in their decisions regarding counterterrorism measures. Attacks on private parties are increasing at a rapid pace, indicating the need for greater security for the hardest-to-defend targets.

**Literature review**

Previous time series research has led to the current analysis and interest in the topic of attack and target diversity among terrorists.[1] Some of the time series literature on terrorism has focused on the substitutability and complementarities among different attack modes and target choices. Enders & Sandler (1993) identified substitutions and complementarities among transnational attack modes. For example, metal detectors in airports reduced skyjackings and diplomatic incidents, but increased assassinations and kidnappings. Similarly, Brandt & Sandler (2009) found that transnational kidnappings and skyjackings are substitutes for one another, while skyjackings and other hostage events are positively correlated or complementary. Therefore, policies designed to thwart skyjackings would also deter other hostage events but may increase kidnappings. Our study builds upon these findings by investigating how substitution opportunities have changed over time for transnational and domestic terrorists.

Recently, changepoint analysis has been used to identify structural breaks in terrorism due to the simultaneous attacks on 11 September 2001 (henceforth, 9/11). Lee, Enders & Sandler (2009) used the Bai & Perron (2003) structural break test and sequential importance sampling MCMC and Brandt & Sandler (2009) used RJMCMC estimation to conclude that 9/11 was not a structural break or changepoint in transnational terrorism. In the current study, we also do not find a changepoint at 9/11 for either domestic or transnational terrorism. Enders & Sandler (2005) found evidence of substitution away from complex transnational terrorist events and toward simpler ones in the post-9/11 world. In the current study, we find that this substitution toward simpler events can be traced back earlier than 9/11 for both types of terrorism.

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[1] Time series models have also been applied to investigate the impact of terrorism on tourism (e.g., Drakos & Kutan, 2006) and growth (e.g., Eckstein and Tsiddon, 2004). Panel estimates have also examined the survival of terrorist organizations, the root causes of terrorism, and other issues beyond the scope of the current study (see, e.g., Blomberg, Engel & Sawyer, 2010; Piazza, 2011).

We derive many of our results from a Bayesian changepoint analysis that endogenously chooses the number and location of changepoints in a time series of counts. Other researchers have used specified breakpoints, unknown breakpoints, or a mix of both to derive their results. For example, Enders & Sandler (1993) used exogenously given changepoints to identify the effectiveness of terrorism policy – e.g., metal detectors in airports, embassy security, and the US retaliatory raid on Libya in 1986. Yaya (2009) used 9/11 and the Iraqi War of 2003 as pre-specified exogenous changepoints to gauge their influence on Turkish tourism, while Barros & Gil-Alana (2006) used important political events to ascertain the impact on ETA terrorist attacks. A mix of specified and unknown breakpoints was employed by Enders, Liu & Prodan (2009). They enlisted regime-switching models to discover unknown breakpoints and then tested the validity of forecasting models by investigating which models were able to identify the 'known' breakpoints.

More recently, endogenously found breakpoints have yielded interesting results. Brandt & Sandler (2009) applied a Bayesian RJMCMC analysis to identify changepoints in three transnational hostage-taking series (kidnapping, skyjackings, and other). In so doing, they found that a no-concession policy should be maintained because past concessions encouraged 2.62 future kidnappings. Brandt & Sandler (2010) employed a Bayesian Poisson changepoint analysis to show how transnational terrorists have responded to target hardening. They found that transnational terrorists sought to target people over property, with an increasing emphasis on private parties. We expand on these articles by focusing on both transnational *and* domestic terrorism and on *both* target types and attack modes. In so doing, we discover that the hardest-to-defend target-attack combination has become the preferred combination for transnational and domestic terrorists.

**Background and data**

Terrorism is the premeditated use or threat to use violence by individuals or subnational groups with the intent to gain political or social goals.  The use of intimidation techniques by terrorists is meant to affect a larger audience beyond that of the immediate victim.  Violence and intimidation applied for personal gains is a criminal act rather than terrorism.  Domestic terrorist events are conceived, planned, and executed in the host country and only involve entities from the host country.  Many suicide bombings in Iraq killed local police and citizens and would qualify as domestic terrorist events.  The Oklahoma City bombing on 19 April 1995 by Timothy McVeigh was a notorious example of domestic terrorism in the United States.  The Norway shooting and bombing massacre on 22 July 2011 by right-wing extremist Anders Breivik was another horrific example of domestic terrorism.  By contrast, transnational terrorism involves perpetrators, victims, or targets from two or more countries.  For example, the assassination of an American ambassador by an Iraqi terrorist would constitute a transnational terrorist event.  The most notable transnational terrorist event was 9/11, in which foreign terrorists attacked citizens from over 80 countries on US soil.  The Madrid train bombing on 11 March 2004 by Islamic fundamentalist terrorists, which killed 191 people and injured 1,800, is another example of a transnational terrorist event.

For our analysis, we use event count data from the *Global Terrorism Database* (GTD), which spans from 1970 to the end of 2010 and includes a collection of terrorism-related variables.  The current GTD database was begun in 1970 by the Pinkerton Global Intelligence Services (PGIS) and continued until 1997.  Like other terrorist event data, PGIS coded incidents' characteristics, based on accounts gleaned from the wire services, government documents, and newspapers.  In 2006, drawing on funding from the Department of Homeland Security, the

National Consortium for the Study of Terrorism and Responses to Terrorism (START) extended

GTD beyond 1997 and cleaned the data for 1970–1997 (START, 2010).

We focus on attack mode and target type variables of domestic and transnational

terrorism. GTD separates attack modes and target types into 9 and 22 categories, respectively.

We partition attack modes into four categories: hostage events, bombings (e.g., explosive

bombings and letter bombings),[2] armed attacks, and assassinations (i.e., a politically motivated

murder). Unarmed assault and unknown attacks are excluded from consideration because we

cannot attribute these to a particular type of attack. Target types are divided into four categories:

private parties, business, officials, and military. Terrorist and violent political parties are

excluded as targets because we are concerned with terrorist attacks committed on nonterrorist

targets. Finally, other and unknown targets are not included since they are not attributed to one

type of target.

There are a few issues in using GTD that we resolve. First, GTD does not separate

domestic and transnational terrorist events. We apply the method devised in Enders, Sandler &

Gaibulloev (2011), which painstakingly separated events in order to resolve this issue. Second,

the data for 1993 were lost in an office move by PGIS and have never fully been recovered

(START, 2010). Although incident totals and country-specific data are available, the full

complexity of the data is unavailable. Third, START changed the definition of terrorism that

they used to identify terrorist events for 1998 and thereafter. After 1997, we exclude attack

observations that do not satisfy three GTD inclusion criteria: (i) the presence of a political, socio-

economic, or religious motive; (ii) the intention to coerce, intimidate, or send a message to an

audience beyond the immediate victim; and (iii) outside of the precepts of international

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[2] We choose just four attack modes to fulfill data-intensity requirements of the changepoint methodology. With four attack modes and four target types, we already have many potential sources for changepoints. We acknowledge that a finer distinction, say, among bombings may yield additional changepoints.

humanitarian law. Doubtful cases of terrorism are also excluded. START notes that, due to these inclusion criteria, there are differences in the levels of attacks before and after 1997. At a later point, we find changepoints for 1993 and 1997 for the domestic and transnational terrorist series. The direction of these changepoints indicates decreases in terrorist events that are anticipated from the measurement errors; therefore we estimate, but do not substantively interpret these changepoints in our analysis.

Using only these partitioned GTD data, we investigate the relationship between domestic and transnational terrorist events. We begin by looking at the correlation between the domestic and transnational terrorist series as a whole, which is 0.56, indicative of highly correlated series. Since coding conventions changed after 1997, we check the correlations for pre-1997 and post-1997 to discern any change. The correlations between domestic and transnational terrorism are 0.53 and 0.52 for pre-1997 and post-1997, respectively.

Enders, Sandler & Gaibulloev (2011) stated that domestic and transnational terrorist events should be positively correlated due to several factors. First, domestic terrorist events can spill over into the international community. Second, terrorists, who primarily focus on domestic terrorist events, may seek greater media attention by resorting to some transnational terrorist attacks (Blomberg, Gaibulloev & Sandler, 2011). In particular, domestic terrorists may use spectacular transnational terrorist attacks that result in massive human and monetary losses (Arce & Sandler, 2010). Third, retaliatory and protest events of both domestic and transnational terrorist events can flare up in response to political and military actions; e.g., the Iraqi elections in 2005 and the Arab-Israeli conflicts. Fourth, Blomberg, Gaibulloev & Sandler (2011) found that survival of a terrorist group is dependent on how that group mixes between domestic and transnational terrorist events. Transnational terrorist groups that use a greater ratio of domestic terrorist events tend to survive longer. Finally, demonstration effects can cause increases in both

forms of terrorism 'as terrorists copy one another's innovations' or the authorities copy

counterterrorism innovations.

**Theoretical model**

The theoretical framework we use is an augmented version of the terrorist choice model of

Brandt & Sandler (2010). In this augmented version, we control for both target types *and* attack

modes. In a given period, a representative terrorist group maximizes its utility, $U$,

$$U\left(T_{11},...,T_{14};T_{21},...,T_{24};T_{31},...,T_{34};T_{14},...,T_{44}\right), \tag{1}$$

by choosing target $i$ and its associated attack mode $j$, denoted $T_{ij}$, where $i, j = 1,2,3,4$. These

$T_{ij}$ are continuous choice variables. The utility function is assumed to be strictly increasing and

strictly concave in its 16 target-attack arguments – without loss of generality, additional target-

attack combinations can be allowed. The latter would be relevant if we, say, wanted a finer

breakdown of hostage-taking or bombing incidents. In any given period, the terrorist group is

constrained by a resource constraint,

$$R = \sum_{i=1}^{4}\sum_{j=1}^{4} C_{ij}T_{ij}, \tag{2}$$

where $R$ is the group's resources at a given point in time. In equation 2, $C_{ij}$ is per incident

expected marginal costs of attacking target type $i$ with attack mode $j$, in which each target-attack

combination has its own marginal costs.

The terrorist group chooses its set of $T_{ij}$ to solve the following constrained optimization

problem:

$$Max\left[U\left(T_{11},...,T_{14};T_{21},...,T_{24};T_{31},...,T_{34};T_{14},...,T_{44}\right) \middle| R = \sum_{i=1}^{4}\sum_{j=1}^{4} C_{ij}T_{ij}\right]. \tag{3}$$

The associated first-order conditions (FOCs) are as follows:

$$\frac{U_{11}}{C_{11}} = ... = \frac{U_{14}}{C_{14}} = ... = \frac{U_{41}}{C_{41}} = ... = \frac{U_{44}}{C_{44}} \ . \tag{4}$$

The second-order conditions are satisfied, given the strict concavity of the utility function and the linearity of the resource constraint. For an interior solution, the FOCs equate the marginal gain per dollar spent across all target-attack combinations. If, for example, the marginal gain per dollar spent of using a bomb to attack a private citizen is greater than that of kidnapping an official, then the terrorist group will choose to bomb the private citizen. When countermeasures are deployed that raise the marginal costs of one target-attack combination relative to other combinations, then the terrorist group will make a predictable substitution away from the target-attack combination with the now higher marginal costs. When, therefore, metal detectors in airports were implemented at the start of 1973, terrorists' marginal costs for skyjackings for all target types increased, and they shifted towards other forms of hostage events (e.g., kidnappings) for all target types.

The FOCs in equation 4 indicate that terrorists respond to both the perceived marginal gains and marginal costs associated with target-attack combinations. Terrorists will still engage in events with elevated marginal costs if they see an offsetting increased marginal gain. After 9/11, skyjackings became more costly for terrorists to perform owing to enhanced security; however, successful skyjackings would gain more media attention and this could offset the augmented costs. Hence the authorities must still anticipate such events.

The model also informs about how terrorists worldwide respond to two major drivers: (i) changes in the dominant terrorist tastes, and (ii) changes in security measures. At the global level, the utility function in equation 1 now represents some aggregate terrorist tastes that account for the driving influence of terrorism (e.g., leftist or fundamentalist). Equation 4 then indicates that if the dominant driver comes to favor greater indiscriminate killings, then target-

attack combinations will favor bombings and armed attacks of private parties. This change occurred during the 1990s as the fundamentalists became the dominant driver of transnational terrorism. Moreover, increases in the marginal costs, $C_{ij}$s, of target-attack combinations will shift terrorist operations to those target-attack combinations, where security has not been raised. After 9/11, homeland security increased the marginal costs of attacking buildings, infrastructure, and airports, thereby making bombings of private parties in public places more attractive. Thus, we have the following two hypotheses:

H1: A change in the dominant terrorist tastes will shift attacks to those target-attack combinations favored by these tastes.

H2: Security enhancements that make some target-attack combinations more costly to attack will shift terrorist operations to those combinations, not protected by these security enhancements.

The marginal benefit/marginal costs ratios in equation 4 are subject to changes from taste and security considerations. Moreover, these changes are apt to be greater at the domestic level, where aggregate terrorist tastes have more underlying influences. Thus, we have:

H3: The data-generating process for target-attack combinations fluctuates over time, so that changepoints (or changes in arrival rates) are anticipated in the various time series of terrorism. Moreover, we expect domestic terrorism to display more changepoints than transnational terrorism.

**Bayesian multiple changepoint estimation: A Poisson model**

To identify the changepoints in each series, we employ a Poisson changepoint model, estimated with a Reversible Jump Markov chain Monte Carlo (RJMCMC) algorithm. This RJMCMC method was introduced by Green (1995) and is a robust Bayesian analysis that can estimate an unknown number of changepoints or different dimensional parameter spaces. It does not require the user to choose exogenously the number of changepoints. The RJMCMC Poisson changepoint model samples from the posterior distribution of the parameters and determines whether $k-1, k,$ or $k+1$ changepoints best describe the data. The model is a Poisson process and uses a Markov chain step to jump between differing numbers of changepoints in the parameter space and different model specifications. The Poisson likelihood function for a particular series, say bombings, is determined by the arrival rate function, $w(t)$; the total number of terrorist events, $n$; the total elapsed days, $L$, of the bombing events; and the number of bombings per day, $y_i$, $i = 1, 2, ..., n \in [0, L]$. This likelihood function is:

$$\sum_{i=1}^{n} \log\left(w\{y_i\}\right) - \int_{0}^{L} w(t) dt. \tag{5}$$

The changes in the arrival rate are modeled as a step function, with each new step indicating a new changepoint. The prior for the number of changepoints, $k$, is a truncated Poisson distribution with mean $\lambda$,

$$p(k) = \exp(-\lambda)\frac{\lambda^k}{k!}. \tag{6}$$

For our analysis, the maximum number of changepoints per series is truncated at 40, or one per year. The prior for $\lambda$ is two changepoints, consistent with the Bai-Perron analysis of Enders & Sandler (2005).

The height of the step and its location are calculated to determine the correct direction and time of the changes in the arrival rate. A number of 'sweeps' are used to sample the posterior via a Markov chain Monte Carlo algorithm and, at each sweep, there are four randomly chosen moves that can occur (see, Green, 1995, 2001). First, any sweep may change the height of the current step or propose a new higher or lower step height – changing the magnitude of the step at the changepoint. The probability of the new height being accepted is then calculated. Second, a new step location can be proposed, changing the date of the changepoint. The probability of accepting the new location is determined. Third, a 'birth' of a new changepoint can be proposed, which must lie within the current step interval and must split the step interval into two subintervals of different heights. The probability of accepting this new changepoint is then calculated. Fourth, a 'death' or removal of a changepoint may occur, where the current step position is removed and the two steps' heights immediately surrounding the current step are merged into one. The probability of accepting a 'death' is then calculated. Based on the acceptance probabilities, the algorithm decides which move to make. It is in the birth and death steps that the reversible part of RJMCMC algorithm comes into play. The sampler allows the model to jump into parameter spaces with more changepoints and reverse back to models with fewer changepoints.

We then perform model diagnostic checks. Plots of the changepoint locations and arrival rates show no overlapping credible intervals and good mixing of changepoints over the entire period. We find nonoverlapping 90% credible intervals, which indicate a high probability that each changepoint falls within its own unique time period.[3] Changepoint position marginal densities are unimodal, or sharply estimated. Gelman and Rubin tests of convergence are near

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[3] The nonoverlapping 95% credible intervals (available upon request) do not differ substantially from the 90% credible intervals. In a few cases, the changepoints differ by a day.

one, indicating approximate convergence. We also find that modifications to the prior number of changepoints do not influence the posterior probability of the number of changepoints.

For our models, we use a sampler with 250,000 sweeps per run and a burn-in of 125,000 runs that allow us to remove the initial conditions. The heights of the steps are independent draws from a Gamma distribution with parameters $(\alpha, \beta)$. We initially set $\alpha = 1$ and $\beta = \dfrac{L}{n}$.

Previous research has kept the initial conditions on $(\alpha, \beta)$ constant (e.g. Brandt & Sandler, 2009). Our current study allows $\beta$ to vary, which modifies the prior step height for the changepoints. When we keep the initial parameters constant, we find wide overlapping credible intervals, which suggest multimodality in the number of changepoints. Because each data series in our analysis is unique in the number of events and length, the use of a fixed or common set of priors does not capture the true structural process inherent in each target-attack mode time series. This requires different priors for the RJMCMC algorithm to allow the data to determine the number and location of changepoints for each time series. The 90% credible interval for each changepoint and parameter values for each model are available upon request.

There are 18 RJMCMC estimations – one for each of the aggregate terrorism series and one for each subset series (e.g. four target types and four attack modes). For example, we run a single estimation for the entire domestic terrorism series and a single estimation for each of the domestic terrorism attack modes (e.g. bombings) and target types (e.g. attacks on private parties). So there are nine RJMCMC estimations for domestic terrorism and nine RJMCMC estimations for transnational terrorism. Finally, we match the changepoints from the subset series to the changepoints of the aggregate series for both types of terrorism in order to develop further insight into the underlying drivers of change for the aggregate series.

**Terrorism: Past, present, and future**

We find 16 changepoints in the aggregate transnational terrorist event series and 23 in the aggregate domestic terrorist event series. Generally, we find more changepoints in the domestic terrorist series compared to the corresponding transnational terrorist series, consistent with Hypothesis 3. Figures 1 and 2 show the plots of the cumulative number of events (solid line), arrival rate of the new events (dashed line) and changepoints (vertical lines) in the domestic and transnational terrorism series, respectively. The 90% credible intervals are indicated by the gray areas around the changepoints, which are non-overlapping. This information is summarized in Table I, which indicates the dates of the changepoints and the likely precipitating event associated with each changepoint for the two aggregate series. The positive and negative signs next to a date indicate the direction of the change, which is determined by its mean arrival rate. When a clustering of changepoints occurs (e.g. two or more changepoints within a six month period), we indicate the overall change. Consider the two changepoints toward the beginning of the transnational terrorism series that occur within four months of each other, 1972-12-29 and 1973-04-12. The mean arrival rate for 1972-12-29 indicates a slight decrease in transnational terrorist events, while the mean arrival rate for 1973-04-12 indicates a large increase in events. The difference between the two mean arrival rates is positive, since the increase from 1973-04-12 is larger than the decrease from 1972-12-29. Thus, the overall direction of the two changepoints is upward, which can be seen in Figure 2. At the beginning of the transnational terrorism series, the mean arrival rate (dashed line) drops at the first changepoint (vertical line) but then increases after the second changepoint.

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We match events to each of the changepoints discovered in the domestic and transnational terrorism series.  The 1970 and 1971 changepoints in the domestic terrorism series were generated by the start of the modern era of terrorism when domestic terrorist violence began to spill over into the international community – e.g., German leftists hitting US assets (Enders & Sandler, 2012; Hoffman, 2006).  Throughout the 1970s, there were dramatic increases in the number of transnational and domestic terrorist events, as seen by the number of changepoints found in both series and the upward turn of the arrival rates.  Hijackings became the first major transnational terrorism epidemic, following the huge publicity and important concessions granted from an El Al hijacking on 22 July 1968 by the Popular Front for the Liberation of Palestine (PFLP) (Hoffman, 2006).  From 1968 to 1972, worldwide hijackings reached a peak of 298 incidents (Landes, 1978).  This surge was brought to an abrupt halt in 1973 by the installation of metal detectors in airports, one of the first major counterterrorism efforts.  Consistent with Hypothesis 2, we find that airline security produced a changepoint in both transnational and domestic terrorism (with a lag) in the upward direction.  Substitution into other forms of attack by both transnational and domestic terrorism explains this increase in the overall level of terrorism.  Enders & Sandler (1993) found that the installation of metal detectors in airports reduced the number of hijackings but increased the number of barricade missions, kidnappings, and assassinations.  We see that the substitution toward other attack modes occurred in *both* transnational and domestic terrorism, so that there was an overall increase in both types of terrorism events following the installation of metal detectors.  When terrorists switched to logistically less complex events, the number of terrorist events rose.  This metal-detector impact on domestic terrorist incidents had not been previously recognized; transnational

counterterrorism measures can have both good and bad consequences on domestic terrorism. The delayed response for domestic events is likely due to metal detectors screening domestic flights with some time delay compared to international flights, especially outside of the United States (Enders & Sandler, 1993).

As transnational terrorist events continued to climb, especially those aimed at government officials, embassy fortifications were enacted in 1976. Consistent with Hypothesis 2, we find changepoints in both domestic and transnational terrorism following the implementation of embassy fortifications. The fortifications reduced attacks on embassies, but had the unintended effect of increasing transnational assassinations (Enders & Sandler, 1993). The direction of the 1976 changepoint for transnational terrorism shows that such attacks increased after the start of these fortifications. The direction of the 1976 changepoint for domestic terrorism, however, shows that those incidents decreased around the time of embassy fortifications, but the precise causal mechanism is unknown for this changepoint. The rise in transnational terrorist events persisted in the late 1970s due to open hostilities and political tensions in the Arab-Israeli conflict. As transnational terrorist events rose, so did domestic terrorist events owing to the high correlation previously noted. Intensification of domestic violence in West Germany, Italy, the Arab nations, and the 1979 Provisional Irish Republican Army (PIRA) bombing campaign appear to have directly influenced the rise of domestic terrorist events in the late 1970s through an apparent demonstration effect.

In the 1980s, there was a continuation of increased transnational terrorist events due to the rise of state sponsorship of terror and a new focus toward increased bloodshed, consistent with Hypothesis 1 (Hoffman, 2006). Both transnational terrorism changepoints in this decade display an increase in attacks. High levels of domestic terrorist events were maintained until 1986, stemming in part from state-sponsored groups that engaged in both kinds of attacks. There

was a momentary respite around the time of enhanced embassy fortification begun in 1986. In 1987, domestic terrorism events rose again with the Afghan terror campaign. This event focused on assassinations, armed attacks, and bombings of private parties and would later spill over into Pakistan and other countries (US Department of State, 1987, 1988).

During the 1990s and up until 9/11, terrorism is characterized by a 'fall of communism, which marked a decline, but not elimination, of state sponsorship' (Alexander & Pluchinsky, 1992). During this time, the driving force of both types of terrorism is taken over by religious fundamentalists. This dominance spurred an increase in domestic terrorist events in agreement with Hypothesis 1, as seen in the upward direction of the 2001 changepoints. The Persian Gulf War and the 12 October 2000 attack on the USS *Cole* are notable transnational terrorist events that spawned changepoints. There is a decline in transnational terrorism from 1991 to 2000, which may be due to four reasons. First, state sponsorship was greatly reduced so that state sponsors, such as Libya and Syria, found themselves in financial peril and isolated from the rest of the world. Second, the fall of the Soviet Union gave birth to new countries that sought better relations with the global community. Thus, they began to police terrorism in their own countries. Third, there was a significant increase worldwide in the adherence to the rule of law – see Choi's (2010) novel study. A greater adherence results in fewer dissatisfied individuals who resort to terrorism. Fourth, many left-wing terrorist groups ended operations (Alexander & Pluchinsky, 1992). In the post-Cold War era, the average number of transnational terrorist incidents fell, but the severity of the incidents increased, leading to more casualties (Enders & Sandler, 2000). Significant domestic and transnational terrorism events that occurred in the 1990s, and would be anticipated to cause a changepoint, coincided with the previously mentioned measurement issues. The 26 February 1993 World Trade Center bombing in New York City overlaps with the missing data for 1993. The 7 August 1998 simultaneous bombings of the US embassies in

Nairobi, Kenya and Dar es Salam, Tanzania occurred less than a year after the GTD

measurement change of 1997. Therefore, it is difficult to identify whether or not a changepoint

during these times was due to an actual event or a measurement issue.

The post-9/11 world began with the 'War on Terror,' which sparked rapid increases in

both domestic and transnational terrorist events. Due to escalating fighting and deteriorating

substitution opportunities, both domestic and transnational terrorists focused on simpler methods

of attack, such as bombings, and targeting soft targets, such as private parties. Many events

during this period affected both kinds of terrorism. The 2005 Iraqi elections and the 2007

intensification of bombings in Iraq increased both types of terrorist events worldwide. In 2008,

the War on Terror and successful countermeasures helped reduce the strength of Al Qaeda,

leading to a reduction in transnational terrorism events. Then in 2010, the US announcement and

combat troop pullout in Iraq may have caused an increase in both domestic and transnational

terrorist incidents, since both time series increased.

To understand where terrorism is headed in the future, we must understand the nature of

target and attack choice as shown in Figure 3. The panels show the cumulative number of

domestic and transnational terrorist incidents by either target type or attack mode. In general,

there are up to four times as many domestic terrorist events as there are transnational ones.

Therefore, the scaling of the *y*-axis is not the same for both terrorism types. Enders, Sandler &

Gaibulloev (2011) showed that domestic terrorism Granger-causes transnational terrorism, but

that transnational terrorism does not Granger-cause domestic terrorism. This suggests that

terrorists begin new campaigns and methods at the domestic level that spill over into the

transnational level, so that domestic terrorism leads transnational terrorism. Panels 3A and 3B

show the cumulative number of domestic and transnational terrorist incidents by target type.

From these figures, it is evident that domestic terrorism is leading transnational terrorism in

terms of target choice. From 1970 to 1981, officials and business targets were the target of

choice for domestic terrorists. By 1981, private parties surpassed both officials and business

targets as the target of choice. Private parties remain the favored target choice of domestic

terrorists.

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A similar story arises with transnational terrorists. Officials and business targets vied for

the favored target of transnational terrorists until 1992, when private parties surpassed them as

the preferred target. Domestic terrorists began favoring private parties at the start of the 1980s,

whereas it took transnational terrorists until 1992 to do so. The ten-year difference is due to

domestic terrorists recognizing sooner than transnational terrorists that private parties were softer

targets to attack and exhibited better extortion opportunities. Business targets became harder to

attack over time as businesses took steps to protect their assets. Officials were difficult targets to

attack due to embassy fortifications, training for personnel, and the no-concession policies that

most governments enacted. Now that both forms of terrorism favor attacks against private

parties, the gap between attacks on private parties and those on officials and business targets is

ever widening. The rate of attacks on private parties continues to increase at an alarmingly rate.

In the 1970s, attacks on private parties accounted for 26.7% and 31.7% of transnational and

domestic terrorist attacks, respectively. For 2000–2010, these percentages grew to 50% and

53.1%, respectively. There is a need to secure private parties from both types of terrorism.

Panels 3C and 3D show the cumulative number of domestic and transnational terrorist

incidents by attack mode. Bombings have been the preferred attack mode for both kinds of

terrorism since the start of the series in 1970. As such, bombings make up over 50% of all attacks. This is not surprising because bombings are the simplest and cheapest form of attack as compared to more complex events such as hostage-taking incidents, which may take months of planning and large monetary outlays to execute. There is a striking difference in the number of hostage events for transnational and domestic terrorists. Hostage events account for almost 25% of all attacks for transnational terrorists and just over 1% for domestic terrorists. This is due to an undercounting of hostage events in the domestic terrorist series (Enders, Sandler & Gaibulloev, 2011). GTD was originally constructed to assess terrorism risk abroad. As a consequence, domestic hostage events were not viewed as a threat to GTD clients and, therefore, rarely were tabulated. The dramatic increase in bombing events toward the end of both series indicates that bombings are becoming an even greater threat to the global community.

To find the drivers of transnational and domestic terrorism, we match the changepoints from the subset time series to the corresponding aggregate time series. Tables II and III indicate the driving attack modes and target types for each changepoint in domestic and transnational terrorism. Both domestic and transnational terrorists favored bombings as their main form of attack. Overall, bombings account for 19 of the 23, and 11 of the 16 changepoints for domestic and transnational terrorist events, respectively. This changepoint dominance is traced to a couple of causes. First, bombings are logistically simpler than hostage incidents, assassinations, and armed attacks so that innovations by both the perpetrators and the authorities are relatively easy, leading to more changepoints. Second, bombings are a composite of more modes of attacks (e.g., suicide bombings, letter bombings, explosive bombings, rocket-propelled grenades) than the other composite attack modes, which will result in more changepoints. For domestic terrorists, bombings have dominated throughout the lifetime of the series. Armed attacks and assassinations share a changepoint with domestic bombings numerous times, indicating that

domestic terrorists tended to use armed attacks and assassinations in conjunction with bombings or as an accessory to bombings. At only changepoint 2003-04-12, are armed attacks solely a driver for change in the domestic terrorism. The evidence suggests that domestic terrorists will continue to use bombings as their main mode of attack into the future.

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Tables II and III in here

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Transnational terrorists have a similar pattern. Bombings display a disproportionate influence on changes in terrorist campaigns during the 1970s. However, during the 1980s and 1990s, armed attacks and assassinations were catalysts for change. During these decades, state-sponsored attacks were important and fundamentalist terrorists were becoming a dominant driver of transnational terrorism. State-sponsored terrorists (e.g., Abu Nidal Organization) employed armed attacks (e.g., the massacres at Vienna's Schwechat Airport and Rome's Fiumicino Airport on 27 December 1985) to grab headlines and create anxiety. Moreover, unlike left-wing terrorists, religious fundamentalists were out for carnage. With that motive came a change in tactics and ideals consistent with Hypothesis 1. During their rise to prominence, the fundamentalist terrorists increased their use of armed attacks and assassinations at the start of the 1980s into the early 2000s. Transnational terrorists have returned to a heavy reliance on the use of bombings, since all current changepoints include bombings in some capacity as a driving force. This change is likely attributed to Al Qaeda and its associated groups becoming major players in terrorism. Horrific bombings, such as the 11 March 2004 Madrid train station bombing and the 7 July 2005 London subway bombings, have been linked to groups associated with Al Qaeda. These bombings and others like them attacked soft targets during a time when Al Qaeda was stressed by the War on Terror. Moreover, the huge increase in airport security and

other forms of homeland security in rich countries after 9/11 has favored simple tactics such as bombings.

Similar to bombings, private parties accounted for a large number of changepoints for both domestic and transnational terrorists. From Table II, we see that private parties accounted for 7 of the 11 domestic terrorism changepoints during the 1970s. However, domestic terrorists targeted business and officials during this period, accounting for 4 of the 11 changepoints each. Increases in target hardening brought about by counterterrorism measures such as metal detectors in airports and embassy fortifications made targeting businesses and officials more difficult as the years progressed. Businesses took steps to guard their people and property. By the mid-1970s terrorists also began to seek spectacular events that would draw a larger worldwide audience to their cause. Thus, softer targets such as private parties and media attention-grabbing targets such as government officials began to be favored. In the 1980s, we find that private parties and military targets dominated the changepoints. Domestic terrorism during this time was driven less by religious fundamentalism and more by left-wing, right-wing, and ethnic-nationalists (Gaibulloev, Sandler & Santifort, 2012). Terrorists would attack military targets because they represented the authority that the groups were protesting against. Today, private parties still dominate as the target of choice for domestic terrorists.

In Table III, transnational terrorism tells a somewhat different story. During the 1970s, transnational terrorists initially favored those responsible for their political grievances – namely, officials. Attacks against business targets provided a source of funding, especially for hostage incidents, and was a driver of change. As embassies were fortified and official venues were protected, transnational terrorists increasingly targeted private parties and businesses. This switchover was driven by two considerations. First, the leftists lost their dominant position to the fundamentalists. The leftists wanted to win over the hearts and minds of citizens, while the

fundamentalists viewed private parties as acceptable, even desirable, targets. Second, officials, military, and business targets increasingly protected themselves, leaving private parties the most vulnerable to attack. After the start of the War on Terror, the fundamentalists had greater grievances against officials and would target them despite the enhanced risk. The perceived marginal gain from murdering officials had increased. If such attacks succeeded, then they would garner more media and worldwide interest. Thus, both Hypotheses 1 and 2 are behind these changepoints. The above trend has continued today with private parties and officials as the main drivers of transnational terrorism changepoints.

Over time, the bombing of private parties has become the preferred target-attack combination for both domestic and transnational terrorists. As substitution opportunities have been depleted, both types of terrorists have shifted campaign strategies toward the hardest-to-defend target-attack combination. Hence, counterterrorism measures must be aimed at curbing this increasingly deadly threat.


**Diversity**

Investigating the diversity in terrorist attacks gives increased understanding of the dynamics behind domestic and transnational terrorism. To compute the diversity of terrorist attacks and targeting, we employ the Herfindahl index,

$$1 - \sum_i s_i^2 , \tag{7}$$

where $s_i$ is the share of total attacks on target type $i$ when measuring target diversity. Analogously, $s_i$ is the share of the $i^{th}$ attack mode in total attacks when measuring mode diversity. These diversity measures range from 0 to 1, with 0 indicating no diversity and 1 indicating complete diversity.

The previously mentioned bias toward undercounting hostage events in the domestic terrorist series spuriously impacts our diversity findings. When hostage events are included in the calculations, transnational terrorists use a more diverse mixture of attack modes. Conventional wisdom, however, would predict the opposite, because domestic terrorism consists of more groups and campaign strategies than transnational terrorism. As such, domestic terrorists are likely to employ more varied campaigns as a whole than transnational terrorists and not be so influenced by some demonstrated successful mode of attack of another group

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Table IV in here

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Table IV displays the average Herfindahl diversity index for four time periods and overall for domestic and transnational terrorism. For attack mode, Table IV distinguishes the Herfindahl index with and without hostage incidents. In the absence of hostage incidents, domestic terrorist campaigns are more diverse than transnational terrorist campaigns in terms of attack modes within each period and overall. This matches our priors. Diversity in attack modes is also evident based on the changepoints, as shown previously in Tables II and III. Domestic terrorism has a larger proportion of changepoints, consisting of more than one attack mode compared to transnational terrorism. For transnational terrorists, 50% of the changepoints are composed of two or more driving attack modes, which fall to 43% if we exclude hostage events. For domestic terrorism, this proportion is 61% regardless of the inclusion or exclusion of hostage events.

Both kinds of terrorism followed the same pattern in attack diversity through the decades. There was smaller diversity in the 1970s. The rate of attack diversity then increased at an increasing rate until it peaked in the 1990s. In the post-9/11 era, the level of attack mode

diversity fell. As successful countermeasures rose in the 1970s, terrorists substituted away from attack modes that no longer achieved their goals toward other methods. For example, when metal detectors were introduced on 5 January 1973, terrorists were less able to complete skyjackings successfully; thus, they substituted toward kidnapping, barricade events, and other kinds of attacks (Enders & Sandler, 1993). The same thing is spotted here, but on a more aggregate level, as terrorists substituted away from complex events (e.g. hostage taking and assassinations) toward simpler events (e.g. bombings and armed attacks). From 1970 to 2000, simple attack methods accounted for 63% and 83% of transnational and domestic terrorist attacks, respectively. After 2000, these percentages grew to 77% and 87.4%, respectively. In all instances, bombings accounted for more than 70% of simple attacks. Policymakers must anticipate the greater reliance on bombings and develop policy that thwarts them.

Whom a terrorist chooses to target is also an important concern. As discussed earlier, private parties have become an increasingly favorite target as terrorists seek greater carnage and respond to target hardening, in agreement with Hypotheses 1-3. Both domestic and transnational terrorists are almost equal with respect to their overall levels of target diversity, which are much higher than those of attack modes. Even though terrorists increasingly target private parties, they still target officials and businesses. At a single venue, a bomb can kill private citizens, business people, and government officials, which bolsters target diversity.

Through the decades, there has been a general decrease in the level of target diversity, but this decrease is not as sharp as that for attack modes – see Table IV. The more limited target substitution possibility for terrorists is the reason for this decreased diversity. Counterterrorism measures have sought to harden once-favored targets, such as officials, through embassy fortifications and advances in security technologies. As these targets became increasingly more

difficult to attack, terrorists gravitated to private parties. This targeting shift was bolstered by Islamic fundamentalists' fatwa against all nonbelievers.

**Concluding remarks**

Given the great diversity in target-attack pairings for domestic and transnational terrorism, there is a clear need to anticipate which of these combinations are more likely. Counterterrorism resources must be allocated to those combinations that have the highest incidence and pose the greatest costs to society in terms of lives lost and property damage (Bier, Oliveros & Samulelson, 2007; Zhuang & Bier, 2007). Our article has distinguished target and attack diversity not only for the two types of terrorism, but also for four different decades. In so doing, we show that domestic terrorism displays a greater degree of attack diversity than transnational terrorism. The larger attack diversity for domestic terrorism means that effective counterterrorism policy must thwart more forms of attack than in the case of transnational terrorism. Following the onset of the War on Terror, there is a marked decline in the diversity of terrorist attacks and targets. This decline allows the authorities to better focus their scarce resources on more likely target-attack pairings. This is a positive payback from the War on Terror, previously unrecognized, that can conserve on counterterrorism resources. This reduced diversity may be behind the large number of failed terrorist plots since 2002 (Dahl, 2011).

Our study shows that the hardest-to-defend target-attack pairing – bombings of private parties – has experienced the largest increase in violence. As a consequence, public places – market squares, public transit, shopping malls, and common gathering places – have become the most likely venue for terrorist attacks. Policymakers must understand how traditional homeland security actions of hardening historically favored targets and venues – e.g., officials and embassies – have a dark side by deflecting attacks to private parties in public places. The

progression of target-attack pairings means that even larger homeland security budgets may be needed given the plethora of public places. This indicates the enhanced need for intelligence, so that the right venues are protected. It also highlights the importance of proactive measures that can reduce the terrorist threat through arrests and the destruction of terrorist infrastructure.

Terrorists are substituting away from complex events toward simpler ones, especially bombings. This reveals a deadlier world of terrorism that has resulted in increased carnage. With their simplicity and cost effectiveness, bombings are a quick and devastating means of igniting terror. Terrorists today have the ability to act swiftly and effectively to amplify bloodshed. For example, terrorists learn from each other since innovations in terrorism begin at the domestic level and then spill over into the transnational community. Governments should take stronger strides in eliminating domestic terrorist disturbances before they turn into an international problem.

Prime-target countries of transnational terrorism, such as the United States and the United Kingdom, must also work to eliminate domestic terrorism from those countries prone to such violence. By so doing, prime-target countries will not only reduce domestic terrorism but also reduce future transnational terrorist attacks.

**Replication data**

Full replication data, do files, and R input scripts are available at [www.prio.no/jpr/datasets](www.prio.no/jpr/datasets)

**Acknowledgement**

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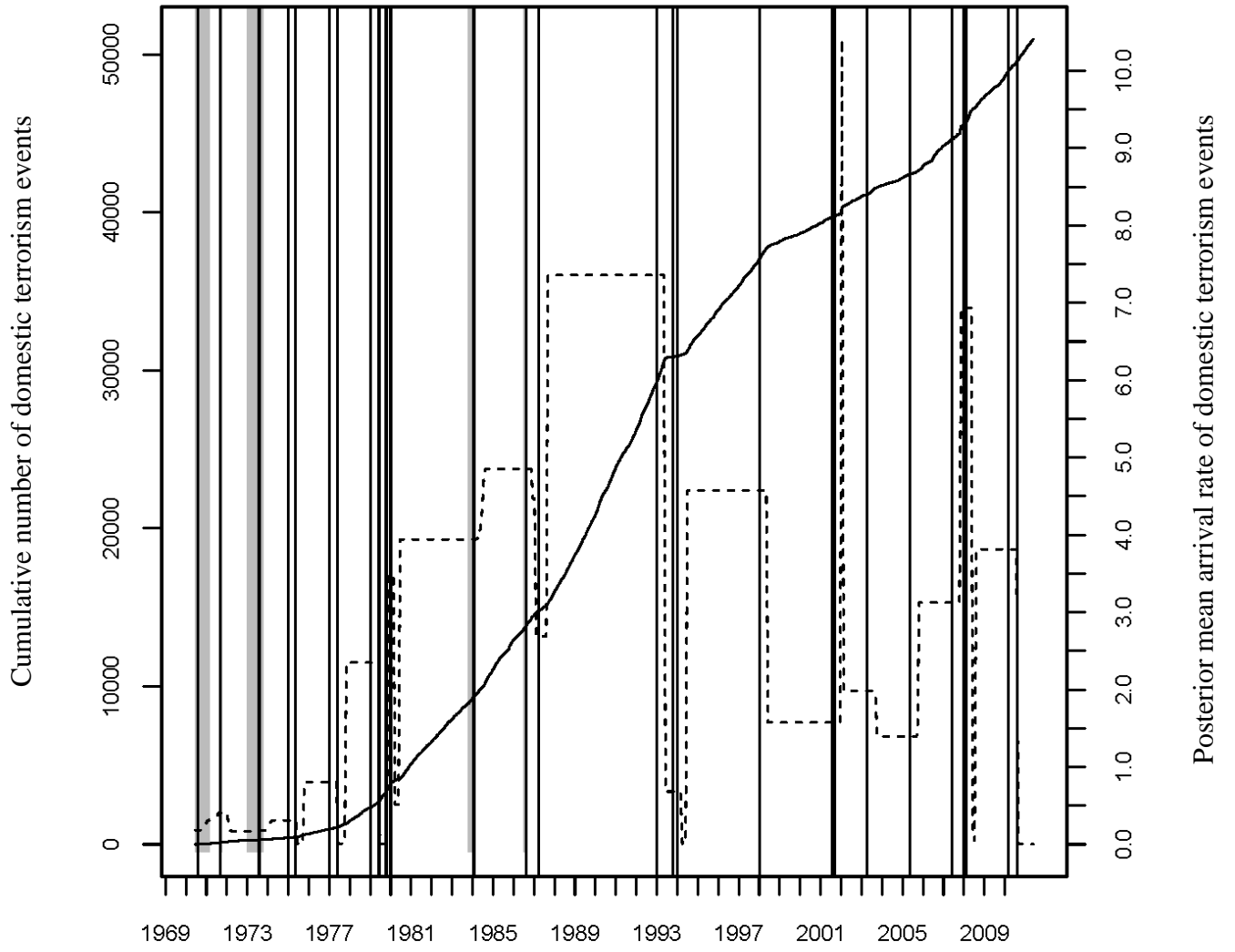
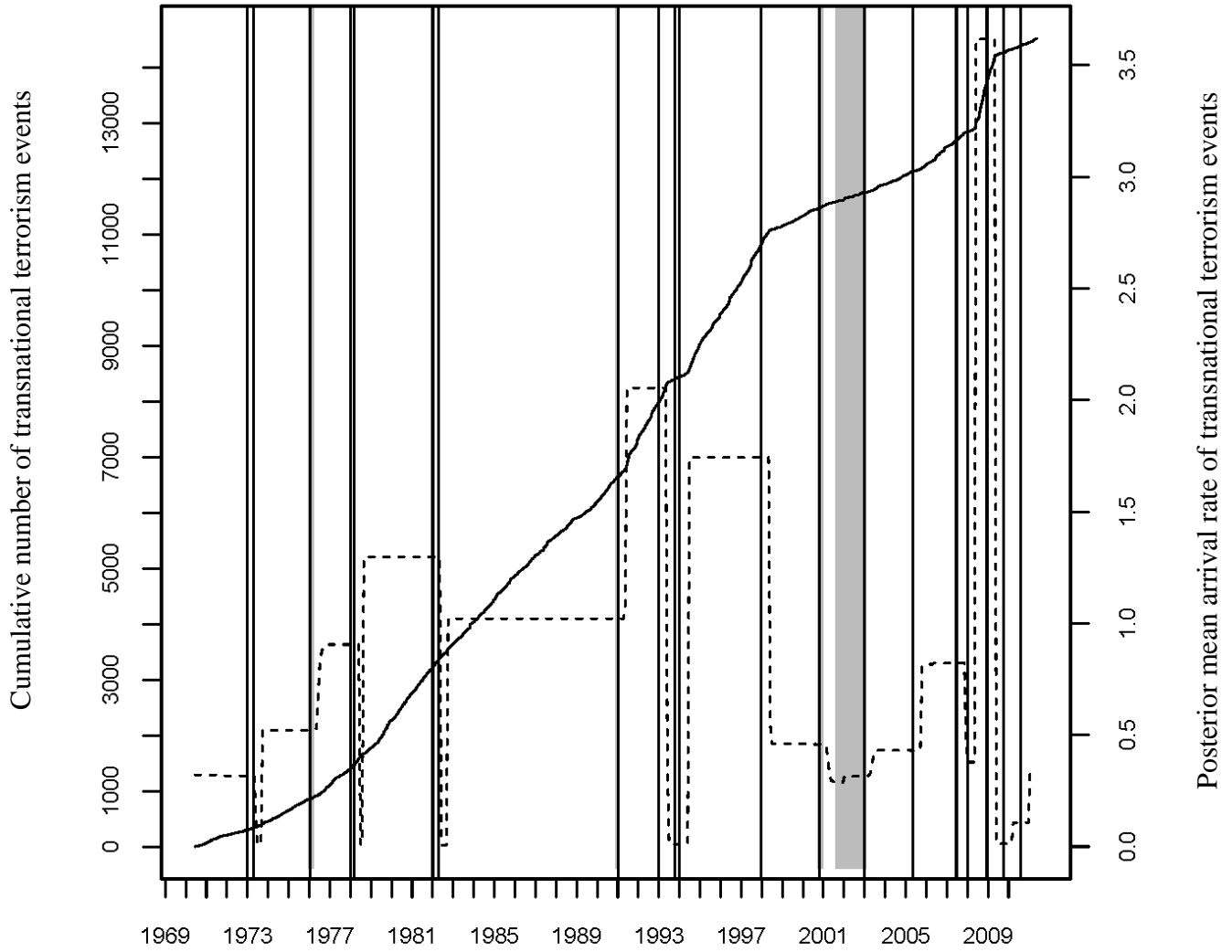Figure 1. Cumulative number and posterior arrival rate of domestic terrorism events, 1970-2010
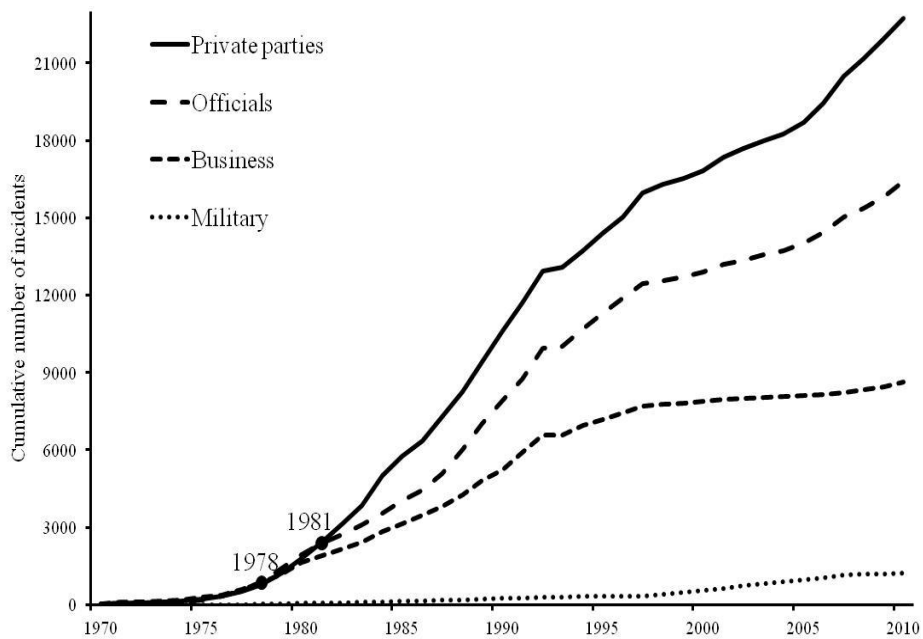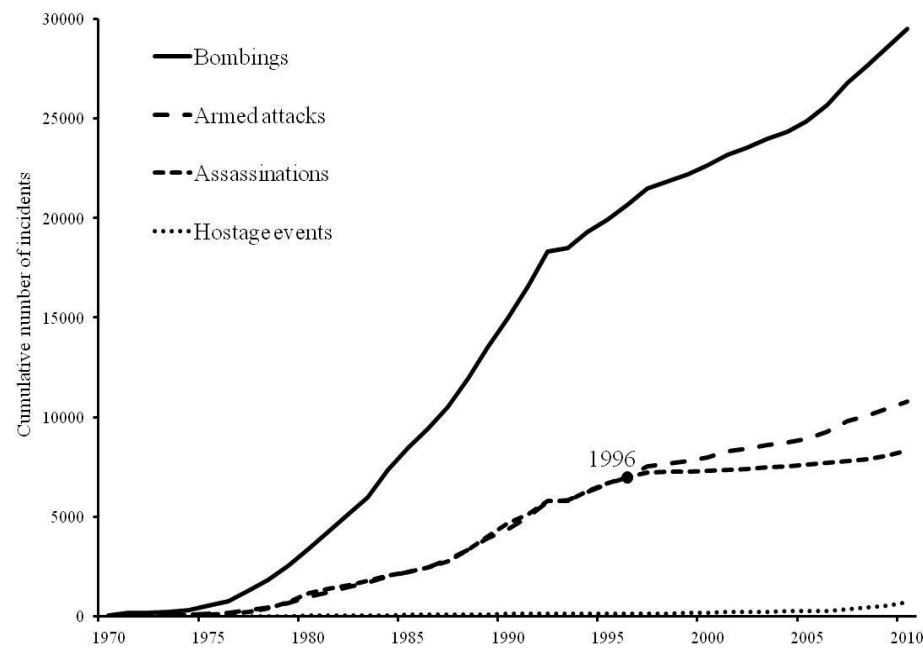
Figure 2. Cumulative number and posterior arrival rate of transnational
terrorism events, 1970-2010
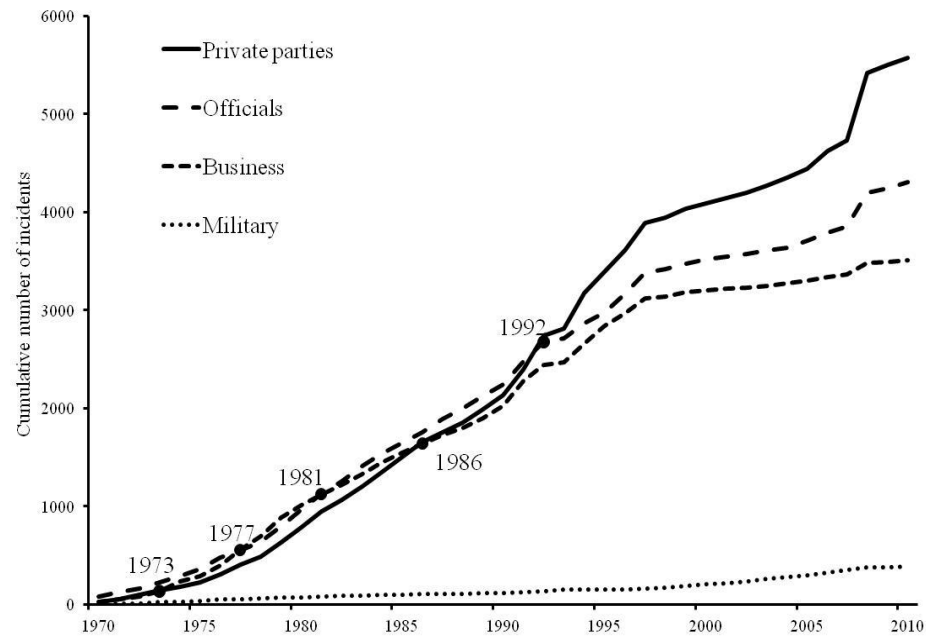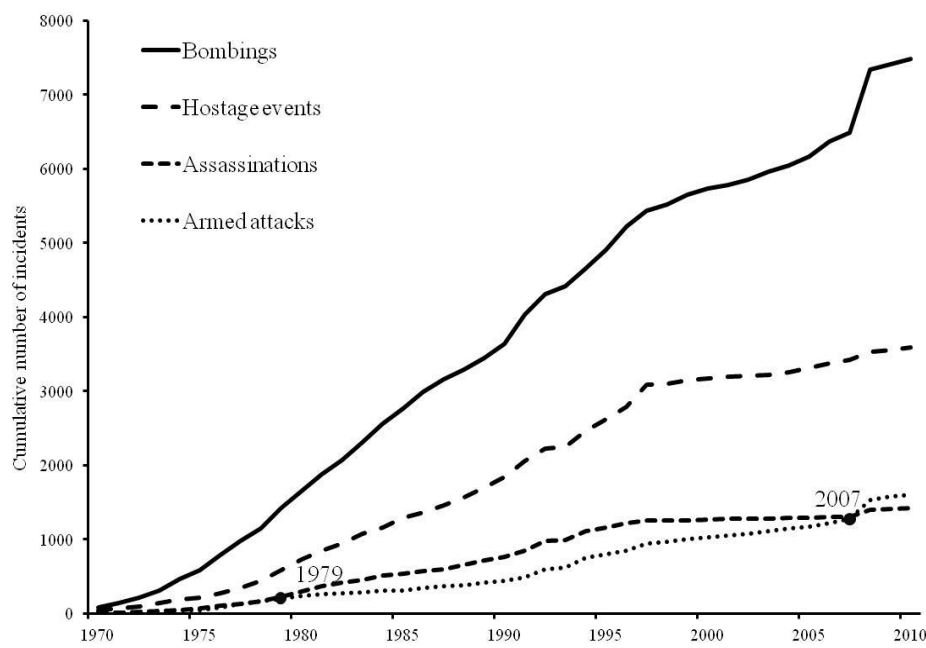
Figure 3. Cumulative number of incidents, 1970-2010