The Economic Impact of Terrorism: A New Model and Its Application to Pakistan

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Abstract

This paper introduces a new economic model to analyze the effects of a possible terrorist attack, namely *the terrorist attack vulnerability evaluation model (TAVE-Model)*. The model analyzes three different phases of terrorism: (i) origins of a terrorist attack; (ii) terrorist attack itself; and (iii) post-attack effects. In addition, the *TAVE-Model* identifies economic desgrowth ($-\delta$), intensity of terrorist activities (α_i), terrorist attack losses ($-\pi$), economic wear (Π) , level of terrorist attack tension (ζ), level of terrorist attacks monitoring (η), and total economic leaking (Ω_t) under a terrorist attack. Finally, we apply the TAVE-Model to Pakistan, a country where terrorism poses a significant socio-economic risk. More specifically, we use the model to assess the relationship between terrorism and the economic performance of Pakistan.

Keywords

Terrorism, Economic Modeling, Economic Desgrowth, Policy Modeling, Pakistan

JEL Code

R11, R12

1. Introduction

Terrorism is often viewed in historical, sociological, psychological, political, or geopolitical terms, but it can have substantial economic repercussions. Catastrophic terrorist attacks such as 9/11 can dent business and consumer confidence, which harms investment and consumption and hence macroeconomic performance. Terrorist attacks that target vital infrastructure such as oil pipelines or railroads can seriously disrupt transportation, communication, and the entire economy. Indeed some terrorist attacks are designed to inflict economic damage in the target country. In addition, the war on terrorism can have a substantial economic effect on both the country waging the war – such as the US – and the home country – such as Afghanistan. For the US, the massive military spending incurred during the war has significant implications for fiscal health. For Afghanistan, a low income country with limited resources, the military spending of the US and its coalition partners was, in effect, a huge boost in foreign aid, with a correspondingly outsized impact on economic growth. Terrorism not only has economic consequences, but also economic causes.

While the root causes of terrorism are multidimensional – ranging from religious extremism to a sense of alienation from society to anger at perceived geopolitical injustice – economic factors can help explain the rise of terrorism. Economic stagnation can limit employment and other economic opportunities for the youth. Lack of economic opportunities can be a powerful driver of terrorism, especially in conjunction with other social and political factors. This problem is especially pronounced in countries with relatively young populations and large numbers of young people. A large and growing army of young people mired in hopelessness and despair about the future provide fertile recruiting grounds for terrorist organizations. Despite the sizable economic causes and consequences of terrorism, there have been very little, if any, formal modeling of the economics of terrorism. Yet formal models could help us to better understand the economic dimensions of terrorism.

The main objective of this paper is to set forth a model – the terrorist attack vulnerability evaluation model (*TAVE-Model*) – to evaluate the economic consequence to the countries in case of terrorist attack. Furthermore, the methodology of the *TAVE-Model* draws on an alternative mathematical and graphical approach analysis framework. To illustrate and illuminate the *TAVE-Model*, we apply it to a terrorist attack by player 2 (P_2) on player 1 (P_1). We hope that the *TAVE-*

Model will enable us to evaluate terrorists attack in a more systematic and accurate way. More specifically, the model can help improve the measurement of the economic impact of a terrorist attack. An important value-added of the *TAVE-Model* is to account for this uncertainty and behavioral change from a new perspective within the framework of a dynamic imbalanced state (DIS) (Ruiz Estrada and Yap, 2013) and the Omnia Mobilis assumption (Ruiz Estrada, 2011).

The idea is to move on from classical economic models such as the linear and non-linear models to a new economic mathematical modeling and mapping of terrorist attacks by using high-resolution of multidimensional graphs and a new mathematical framework. Another innovation of the model is that it explicitly distinguishes between the pre-attack phase and post-attack phase. We believe that our alternative analytical framework can yield new interesting and relevant insights about how to assess more accurately the economic consequences of a terrorist attack.

2. Theoretical Framework of Terrorism

Historical studies such as Keynes (1919), Piguou (1940) and Robbins (1942) have discussed the role of war, peace, and disputes in the economy. After the 9/11 incident, terrorism has received more attention among economists (Blomberg,Hess, & Orphanides 2004). Some economists believe that terrorists are rational actors who want to maximize their objectives subject to resource constraints (Landes, 1978; Sandler, Tschirhart, and Cauley, 1983). The main proposition of our study is that terrorist activities cause poor economic performance. The adverse effects of terrorism on economy can be best explained by the rational choice theory. A government under the threat of terrorist attacks has to fight terrorism on a rational basis. Government thus needs to compare the cost of acquiescing to terrorist demands against the fighting the terrorists in a possibly prolonged campaign (Sandler & Enders, 2008).

Ismail and Amjad (2014) examined the determinants of terrorism in Pakistan. The authors used time series data from 1972 to 2011. Terrorist incidents were used as a proxy for terrorism. The other variables of the study are GDP per capita, political rights, literacy, inflation, unemployment, inflation, poverty, and inequality. Their results indicate that there are long run relationships among the various economic and social variables on one hand and on the other. The results suggest that literacy, poverty, inflation, and GDP per capita are the most important determinants of terrorism in Pakistan. Political repression, unemployment, and inequality have insignificant relationship in the long run with terrorist incidents.

In a paper entitled "Terrorism, development and democracy: The case of Pakistan". Hussain (2003) identified some causes of terrorism from a historical study of the Pakistani economy. He argued that in order for Pakistan to become a moderate and modern Muslim country, it must eradicate poverty and illiteracy, which will help defeat terrorism. Hussain identifies two specific causes of terrorism in the Pakistan economy, illiteracy and poverty.

3. An Overview of Terrorism in Pakistan

Pakistan is finds itself in a challenging geopolitical situation. On one side, there is the long-running Kashmir dispute with India and on the other side, the border with Afghanistan is not secure and subject to infiltration by Islamic militants such as the Taliban. Pakistan has had a terrorism problem since 1947. Historically, there are five events or factors that provoked the growth of terrorism in Pakistan. The first event that generated terrorism in Pakistan was the rise to power of General Zia-Ul-Haq. He was a military dictator who arrested the elected Prime Minster Mr. Zulfiqur Ali Bhutto and subsequently executed him in 1979. As a result of Bhutto's execution, a terrorist group called Al-Zulfikar emerged to take revenge. To fight Al-Zulfikar group, General Zia created a new group called Muhajir Quumi Movement (MQM). In its heyday, MQM may have been responsible for 90 percent of terrorist incidents in Karachi and Hyderabad, and 40 percent in the rest of the country (Fair, 2004).

The second event which generated terrorism is the Iranian revolution of 1979. Before 1980, religion was not considered a major issue in Pakistan society. After this revolution, the Shia-Sunni sectarian conflict intensified. This gave birth to religious terrorism and extremism in Pakistan.

The third event which added fuel to the fire of terrorism was the Afghan war. Militants came from many different regions of the world came to Pakistan to move across the border to fight against the Russian occupation of Afghanistan. Those militants eventually became the foundation of terrorism in Pakistan, especially in the northern part of the country. In fact, they became the root cause of terrorism in many parts of the world. (Weiner, 1998).

The fourth factor or event was the defeat of the Soviet Union in Afghanistan. The control of Afghanistan fell into the hands of Taliban. The Americans formerly supported mujahedeen in the northern part of Pakistan and Afghanistan during the fight against Soviet occupation of Afghanistan. Arab mujahedeen like Osama Bin Laden became the some of the most dangerous terrorists in the world.

The fifth event was the game-changing 9/11 terrorist attacks in the US. The attacks elevated global terrorism to an entirely higher level and provoked US-led military strikes against Afghanistan and the fall of the Taliban regime there. Pakistan provided crucial logistic support to America in its offensive against the Taliban in Afghanistan. One by-product of the US invasion of Afghanistan was the growth of Islamic militancy and terrorism in Pakistan.

The Pakistani economy has suffered a lot due to terrorism. Terrorism has resulted in more than 56,000 deaths and more than 40,000 injuries. In addition, a large number of people were internally displaced and migrated to another part of the country. Terrorism destroyed a lot of infrastructure, worsened the investment environment, affected production, and increased unemployment. Due to heightened risk and uncertainty, domestic and foreign investment stalled, and economic growth slowed down.

The Pakistani economy paid the price of terrorism in terms of both security and economy. During the last decade, the total cost of terrorism (direct & indirect) may be around around US $ 103 billon which is equivalent to Rs 8260 billion. Terrorism has badly affected exports, hindered the inflows of foreign investment, restricted import demand, decreased tax collection, increased defense spending, and harmed both domestic and foreign tourism. Pakistan's investment to GDP ratio fell from 22.5 % in 2006-07 to 13.4 % in 2010-2011. (GoP, 2013). The spatial distribution of terrorism shows that terrorists struck in almost all part of the country, even though some areas were affected more than others (Hussain, 2010). 65 percent of terrorist incidents occurred in the provincial capitals of the four provinces. The most affected areas from terrorism in Pakistan are Peshawar in Khyber Pakhtunkhwa, Tribal areas, Karachi in Sindh, Lahore in Punjab, and Quetta in Baluchistan.

However, the government of Pakistan is taking action to fight terrorism, supported by local military forces and U.S. military forces (logistics and financial support). In particular, the terrorist massacre of a public school in Peshawar on December 16th 2014, where more than 148 children were brutally killed, was a game-changer for the government's attitude and policies on terrorism issues. Immediately after the attack, the government developed a comprehensive national action plan (NAP) to eradicate terrorism (Interior Ministry, 2015).

The first point of this action plan was the establishment of special military courts. The main purpose of these military courts was to expedite terrorist trials. The second point of the action plan was to cut off all sources of funding to terrorist organizations. When the dialogue between the government of Pakistan and the terrorists groups collapsed in the early part of 2014, the government started an army operation named Zarb-e-Azab in June 2014 in North Waziristan; a region near the border with Afghanistan. This army operation was against Tehrik-e-Taliban Pakistan (TTP), the Islamic Movement of Uzbekistan, the East Tarkistan Islamic Movement, Laskar-e-Jhangvi, Al-Qaeda, Jundullah, and the Haqqani network. This operation killed thousands of terrorists were killed.

The government has also taken several steps to scrutinize the foreign funded NGOs, because there is some evidences that some NGOs are supporting terrorist groups. Recently the NGO "Save the Children" was banned, and the government announced that all NGOs operating in Pakistan must register with the interior ministry within six months. The government also announced plans to guarantee the safety of terrorists in Baluchistan, affected province hit hard by terrorism, if they surrender to the government. The Pakistans government is also keen to bring stability to neighboring Afghanistan, a politically unstable country which remains a major source of terrorism. Recently, the Pakistani government helped to kick-start a dialogue session between the Afghan government and the Afghan Taliban, in Murree, Pakistan. The government wants peace and stability in Afghanistan, which is vital to defeating terrorism in Pakistan itself.

4. An Introduction to the TAVE-Model

The terrorist attack vulnerability evaluation model *(TAVE-Model)* is divided into three sections: (i) origins of terrorist attack; (ii) terrorist attack; (iii) post-terrorist effects. Furthermore, the *TAVE-Model* uses three different groups of players. The first group of players is the main conflict players (P_i; i= (1,2). The first player (P_1) is the government forces. The second player (P_2) can be any domestic terrorist group. A terrorist attack is defined as the physical or psychological attack of any armed group or gang on the civil society (Ruiz Estrada and Park, 2008). Therefore, a terrorist attack uses violent and destructive actions without any mercy or compassion for the civil society. A terrorist attack uses sophisticated methods, techniques, and systems of violence and violence to intimidate and humiliate the civil society. In addition, terrorist groups require a strong ideological, political, economic, technological, and social platform to achieve a longer institutional life.

i. Origins of a Terrorist Attack

The *TAVE-Model* that any terrorist attack originates from the following four basic factors: (i) historical issues (ΐ); (ii) economic issues (έ); (iii) ideological and religion differences (Λ); and

(iv) civil society control (μ). These four factors directly affect "the level of terrorist attack tension (ζ)." in this model. The level of terrorist attack tension (ζ) is in function of these four variables (Expression 1.)

$$\zeta = f(\ddot{\iota}, \acute{\varepsilon}, \Lambda, \mu) \qquad (1)$$

Therefore, the next step is to calculate the minimum and maximum level of terrorist attack tension (ζ) through the application of the first derivative according to expression 2 and 3.

$$f'(\zeta) = (\partial\zeta/\partial\ddot{\iota}) + (\partial\zeta/\partial\acute{\varepsilon}) + (\partial\zeta/\partial\Lambda) + (\partial\zeta/\partial\mu) \qquad (2)$$

$$f'(\zeta) = \sum(\lim_{\Delta\ddot{\iota}\to 0} \Delta\zeta/\Delta\ddot{\iota}) + (\lim_{\Delta\acute{\varepsilon}\to 0} \Delta\zeta/\Delta\acute{\varepsilon}) + (\lim_{\Delta\Lambda\to 0} \Delta\zeta/\Delta\Lambda) + (\lim_{\Delta\mu\to 0} \Delta\zeta/\Delta\mu) \qquad (3)$$

Moreover, the level of terrorist attack tension (ζ) applies a second derivative to find the inflection point according to expression 4.

$$f''(\ddot{\iota}, \acute{\varepsilon}, \Lambda, \mu, \rho) = (\partial^2\zeta/\partial\ddot{\iota}^2) + (\partial^2\zeta/\partial\acute{\varepsilon}^2) + (\partial^2\zeta/\partial\Lambda^2) + (\partial^2\zeta/\partial\mu^2) \qquad (4)$$

To probe the level of terrorist attack tension (ζ) is necessary to apply the Jacobian determinants under the first-order derivatives (see Expression 5.)

$$|J'| = \begin{pmatrix} \partial\zeta/\partial\ddot{\iota} & \partial\zeta/\partial\acute{\varepsilon} \\ \partial\zeta/\partial\Lambda & \partial\zeta/\partial\mu \end{pmatrix} \qquad (5)$$

On the other hand, the application of the Jacobian determinants under the second-order derivatives can help to find the inflection point in the level of terrorist attack tension (ζ) between the two players $(P_1 \wedge P_2)$ (see Expression 6.)

$$|J''| = \begin{pmatrix} \partial^2\zeta/\partial\ddot{\iota}^2 & \partial^2\zeta/\partial\acute{\varepsilon}^2 \\ \partial^2\zeta/\partial\Lambda^2 & \partial^2\zeta/\partial\mu^2 \end{pmatrix} \qquad (6)$$

Consequently, in the initial stage of any terrorist attack, we need to assume that the level of terrorist attack tension (ζ) (endogenous variable) is going to determine the level of terrorist attacks monitoring (η) (exogenous variable) via cooperation between external intelligence agencies [R_b; b = (1,2,…,∞)] and domestic intelligence agencies (U). In this part of the *TAVE-Model* we are able to show that if the level of terrorist attack tension (ζ) is rising then the level of terrorist attack monitoring (η) is going to be more intensive, to the point of exhausting all possibilities to get more information of potential terrorist attacks from player 2 (P_2). Hence, the level of terrorist attack monitoring (η) directly depends on the level of terrorist attack tension (ζ) in the short run. In addition, the level of terrorist attacks monitoring (η) also involves the anti-terrorist contingency actions plans in case of a potential terrorist attack anytime and anywhere.

In figure 1 is possible to observe the relationship between the level of terrorist attack tension (ζ) and the level of terrorist attack monitoring (η), evident in a logarithmic curve in the 2-dimensional Cartesian plane (see Expression 7). External intelligence agencies (R) and domestic intelligence agencies (U) may play a crucial role in the level of terrorist attack monitoring (η). According to this research, if the level of terrorist attack tension (ζ) reaches its maximum then the level of terrorist attack monitoring (η) will play an important role in reducing potential terrorist attacks on player 1 (P_1).

$$\zeta = x\log_2(\eta) \;\; \Rightarrow \;\; \{ \eta / \eta : R \cap U \} \quad (7)$$

[INSERT FIGURE 1]

ii. The Terrorist Attack

The terrorist attack consists of two stages – preparatory stage and the attack itself.

Terrorist Attack Preparation Stage

In the pre-terrorist attack stage, it is necessary to assume that both players $(P_1 \wedge P_2)$ have different strategy (ω) levels. (See 8).

$$P_1(\omega_1) \neq P_2(\omega_2) \quad (8)$$

Thus, the levels of total economic linking (Ω_t) for player 1 (P_1) changes by a different amount (Δ), as in (9).

$$P_1(\Delta\Omega_t) \quad (9)$$

In the period of the terrorist attack, the player 1 (P_1) is exposed to risk of heavy or light terrorist attack from player 2 (P_2). This means that if the level of terrorist attack tension (ζ) reaches its maximum limit then the level of terrorist attack monitoring (η) almost fail (see Expression 10.)

$$\zeta_{max} = f'(\eta) = \partial x\log_2(\zeta)/\partial\eta > 0 \quad (10)$$

Accordingly, this part of the *TAVE-Model* requests the application of a second derivative to observe the curve inflection point.

$$\zeta_{max} = f''(\eta) = \partial^2 x\log_2(\zeta)/\partial\eta^2 > 0 \quad (11)$$

The Terrorist Attack

The *TAVE-Model* assumes that if a terrorist attack starts now from player 2 (P_2) on player 1 (P_1), economic desgrowth ($-\delta$) can be large but in different magnitudes P_1 (Δ-δ). The intensity of terrorist attack (α_i) is going to affect total economic leaking (Ω_t). At the same time, economic desgrowth ($-\delta$) and terrorist attack losses ($-\pi$) will show the same trend. We used nine main variables to measure the intensity of terrorist attack (α_i). These nine variables include (i) military external support (α_1); (ii) anti-terrorist attack technological systems (α_2); (iii) army size (α_3); (iv) strategy, information, and logistic systems (α_4); (v) favorable natural and geographical conditions (α_5); (vi) civil society support (α_6); (vii) the terrorist group knowhow (α_7); (viii) transportation, communications, and IT systems (α_8); and (ix) industrial structures (α_9). The *TAVE-Model* also assume that in the long run economic desgrowth ($-\delta$) and terrorist attack losses ($-\pi$) can pose significant difficulties to the recovery of player one (P_1), in different magnitudes, in the post-terrorist attack stage.

$$| J^{'} (\alpha_i) | = \begin{pmatrix} \partial\alpha_i/\partial\alpha_1 & \partial\alpha_i/\partial\alpha_2 & \partial\alpha_i/\partial\alpha_3 \\ \partial\alpha_i/\partial\Lambda & \partial\alpha_i/\partial\alpha_5 & \partial\alpha_i/\partial\alpha_6 \\ \partial\alpha_i/\partial\Lambda & \partial\alpha_i/\partial\alpha_8 & \partial\alpha_i/\partial\alpha_9 \end{pmatrix} \qquad (12)$$

The final calculation is showing in Expression 13.

$$\alpha_i = 1 / | J^{'} (\alpha_i) | \qquad (13)$$

Therefore, the economic wear (Π) due to a terrorist attack depends on changes in economic desgrowth ($-\delta$) and terrorist attack losses ($-\pi$), according to expression 14.

$$\Pi = f(-\delta, -\pi) \qquad (14)$$

The final step is to calculate the total economic wear (Π) due to a terrorist attack, according to expression 15.

$$\Pi = \left[\int_0^1 \Omega_t (\alpha i)^{-nt} dt\right] + \left[\int_0^1 \Omega_t (-\pi)^{-nt} dt\right] - \left[\int_0^1 -\delta (\alpha i)^{-nt} dt\right] + \left[\int_0^1 -\delta(-\pi)^{-nt} dt\right] \qquad \textbf{\textit{(15)}}$$

The next step is to specify the limits of each variable involved in the calculation of the economic wear (Π) due to a terrorist attack, between 0 and 1.

$$\Pi=\left[\int_0^1 \Omega_t\,(\alpha i)^{-nt}\,dt=\lim_{y\to 1}(\alpha i)^{-nt}\,dt=\lim_{y\to 1}\frac{\Omega_t}{n}(1-\alpha i)^{-nt}\right]+\left[\int_0^1 \Omega_t\,(-\pi)^{-nt}\,dt=\lim_{y\to 1}(-\pi)^{-nt}\,dt=\frac{\Omega_t}{n}(1-(-\pi))^{-nt}\right]-$$
$$\left[\int_0^1 -\delta\,(\alpha i)^{-nt}\,dt=\lim_{y\to 1}\frac{-\delta}{n}(1-\alpha i)^{-nt}\right]+\left[\int_0^1 -\delta(-\pi)^{-nt}\,dt=\lim_{y\to 1}(-\pi)^{-nt}\,dt=\frac{-\delta}{n}\left(1-(-\pi)\right)^{-nt}\right] \quad \textbf{(16)}$$

To find the present value of the economic wear (Π) due to a terrorist attack, we assume a uniform rate of intensity of terrorist attack (α_i) and terrorist attack losses (-π) per year, and a continuous rate of discount of –n. Since, in evaluating an improper integral, we simply take the limit of a proper integral, the final result is shown in expression 17.

$$\Pi=\left[\Omega_t\int_0^1 (\alpha i)^{-nt}\,dt=[-\tfrac{1}{n}(\alpha i)^{-nt}]_0^1+\Omega_t\int_0^1(-\pi)^{-nt}\,dt=[-\tfrac{1}{n}(-\pi)^{-nt}]_0^1\right]-\left[-\delta\int_0^1(\alpha i)^{-nt}\,dt=[-\tfrac{1}{n}(\alpha i)^{-nt}]_0^1+-\delta\int_0^1(-\pi)^{-nt}\,dt=[-\tfrac{1}{n}(-\pi)^{-nt}]_0^1\right] \quad \textbf{(17)}$$

In the process of calculating the marginal economic wear (Π) due to a terrorist attack, we apply first-derivative orders (see Expression 18). At the same time, applying the second-derivative order on economic wear (Π) due to an attack helps us to find the inflection point (see Expression 19)

$$\Pi' = \partial\Pi_t/\partial\Pi_{t+1} \quad (18)$$
$$\Pi'' = \partial^2\Pi_t/\partial\Pi^2_{t+1} \quad (19)$$

Hence, the boundary conditions for economic wear (Π) due to a terrorist attack are equal to Expression 20.

$$\Pi' = \partial\Pi'_0/\partial T\,\big|_{t=0} = 0,\ \partial\Pi'_1/\partial T\,\big|_{t=1} = 1,\ \partial\Pi'_2/\partial T\,\big|_{t=2} = 2,\ \ldots,\ \partial\Pi'_\infty/\partial T\,\big|_{t=\infty} = \infty \quad (20)$$

iii. Post-Terrorist Attack Effect

In the post-terrorist attack stage, the player 1 (P_1) is the final loser, which suffers large amounts of economic leaking (Ω_T), losses (-π), and economic desgrowth (-δ) in the same period of the terrorist attack, according to expression 21.

$$P_1(-\pi, -\delta, \Omega_T) < P_2(-\pi, -\delta, \Omega_T) \quad (21)$$

The *TAVE-Model* also assumes that the loser (P_1) is going to have a hard time to recover from the terrorist attack. Economic wear (Π) due to a terrorist attack creates huge economic imbalances, which impede recovery. Intuitively, improving economic desgrowth (-δ) and minimizing terrorist attack losses (-π) in the loser player (P_1) requires a new strategic security plan, international aid, and institutional and society re-organization to adapt to the new political, social, technological, and economic post-attack environment.

$$P_1(\partial\text{-}\delta_o/\partial\text{-}\delta_f) \quad (22)$$

In the long term, the loser players (P_1) can show different magnitudes (Δ) and trends of economic desgrowth (-δ) and terrorist attack losses (-π). Furthermore, the recovery of player P_1 depends on the cooperative efforts of workers, government, and private sector to reduce terrorist attack losses (-π) until they are equal or close to zero.

$$[P_1(\partial\text{-}\delta_o/\partial\text{-}\delta_f) \leq 0] \vee [P_2(\partial\text{-}\delta_o/\partial\text{-}\delta_f) \leq 0] \quad \textbf{(23)}$$

iv. Economic Desgrowth

In this section, we discuss the concept of economic desgrowth (-δ) (Ruiz Estrada, Yap, and Park, 2014), which plays an important role in the construction of the *TAVE-Model*. The main objective of economic desgrowth (-δ) is to create an economic indicator that can help us to analyze how controlled and non-controlled shocks can adversely affect GDP in the short run. Economic desgrowth (-δ) is defined "as an indicator that can show different leakages that is originated from controlled and non-controlled events that can affect the performance of the final GDP formation into a period of one year". The *TAVE-Model* assumes that the world economy is constantly in a state of permanent chaos and subject to different levels of vulnerability according to different magnitudes of irregularities. Economic desgrowth (-δ) applies random intervals, which makes it possible to analyze unexpected shocks from different controlled and non-controlled events. These are shocks that cannot be predicted and monitored easily by traditional methods of linear and non-liner model. This is because we assume at the outset that the world economy is in permanent chaos (Gleick, 1988).

At the same time, the *TAVE-Model* includes the Lorenz transformation assumptions (Lorenz, 1993) to facilitate the analysis of economic desgrowth (-δ). In addition, the TAVE-Model assumes that economic desgrowth (-δ) has a strong connection to total economic leaking (Ωt). The final measurement of total economic leaking (Ωt) is derived by applying a large number of multi-dimensional partial derivatives on each variable (16 variables) to evaluate the changes of each variable (16 variables) between the present time (this year) and the past time (last year). Finally, The calculation of economic desgrowth (-δ) is based on the final real GDP (Or) and total economic leaking (Ωt). This section of the *TAVE-Model* reminds us that total economic leaking (Ωt) always affects economic desgrowth (-δ) behavior. Finally, the modeling of economic desgrowth (-δ) is based on the application of the Omnia Mobilis assumption by Ruiz Estrada (2011) to generate the relaxation of the total economic leaking (Ωt) calculation (non-controlled and controlled events) and the full potential GDP (OP).

5. Application of TAVE-Model to Pakistan

In this section, we apply the *TAVE-Model* to an imaginary terrorist conflict between the Pakistan government (P_1) and domestic terrorist groups in Pakistan (P_2). The illustrative example employs four different players. The first group of players is the main conflict players, namely the Pakistan government ($\mathbb{P}_1$) and domestic terrorist groups in Pakistan ($\mathbb{P}_2$). The second group of players is external players - i.e. the U.S. (P_3) and international terrorist groups (P_4). Hence, we have two different sets of equations denoted by 24, 25, and 26.

$$P_1 = \{x \mid x \in Ri \vee Aj\} \quad \textbf{\textit{(24)}}$$

$$P_2 = \{x \mid x \in Ri \vee Aj\} \quad \textbf{\textit{(25)}}$$

$$(P_1 \cap Ri \cap Aj) \wedge (P_2 \cap Ri \cap Aj) \quad \textbf{\textit{(26)}}$$

The *TAVE-Model* assumes that P_1 (Pakistan government) will get support from U.S. (P_3). On the other hand, P_2 (domestic terrorist groups in Pakistan) will get support from international terrorist groups (P_4). The three main elements that can precede a conflict between P_1 (Pakistan government) and P_2 (domestic terrorist groups in Pakistan) are: (i) historical legacy issues stemming from the Cold War; (ii) rapid expansion of extremist terrorist groups into Pakistan from Afghanistan and other regional countries; and (iii) rivalry for political control of Pakistan. These factors have jointly generated a high level of terrorist tension between P_1 and P_2.

According to the *TAVE*-Model, the level of military tension between P_1 (Pakistan government) and P_2 (domestic terrorist groups in Pakistan) rises from 0.29 in 1990 to 0.75 in 2015. The average economic leaking (Ω_t) from the terrorist war is 0.18 in the 1980s, 0.45 in the 1990s, and 0.75 in 2015. Economic desgrowth ($-\delta$) averaged -0.15 in the 1980s, -0.49 in the 1990s, and -0.87 in 2015. Average war economic wear (Π) was 0.20 in the 1980s, 0.50 in the 1990s, and 0.78 in 2015.

If war intensified between the two main players, we need to take into account their relative weighing. The *TAVE-Mode*l indicates that the relative weighting of Pakistan government versus domestic terrorists is as follows: military external support (5:2); war technological systems (6:2); army size (5:1); strategy, information, and logistic systems (6:3); natural and geographical conditions (7:5); society support (5:2); military knowhow (6:3); (viii) transportation, communications, and IT systems (5:1). P_1 (the Pakistan government) enjoys a clear overall superiority relative to P_2 (the domestic terrorist groups in Pakistan). Therefore, Pakistan government is likely defeat domestic terrorist groups, especially if it can generate more favorable economic and social conditions.

Economic leaking (Ω_t) during the terrorist conflict is equal to 0.65. Wartime economic desgrowth ($-\delta$) is estimated to be -0.62. Finally, war losses ($-\pi$) are -0.79 and economic wear (Π) is 0.89 according to *TAVE-Model*. Therefore, Pakistan's overall economic losses due to a terrorist conflict will be substantial, and post-conflict reconstruction is bound to be a costly endeavor.

6. Empirical Analysis of Terrorism: How Is Terrorism Related to Poverty and GDP?

In this part, using with the sample case of Pakistan, we empirically analyze how changes in both poverty rate and per capita GDP are correlated with change in incidence of terrorist attacks. We used Δ (change in) income per capita and Δ (change in) poverty rate as independent variables, and examined how these two variables affect Δ (change in) terrorist attacks in Pakistan between 1989 and 2013.The incidents of terrorists attacks data are selected from the Global Terrorism Data Base (GTD, 2013). The independent variables data have been taken from the various economic issues of Pakistan economy. Since we use time series data, we implemented Vector Auto Regression (VAR) which can address non stationary and other problems related with time series data.

[INSERT TABLE 1]

As shown in table 3, the estimated results tell us that the first lag and second lag of Δ terrorist incidents are positively correlated with Δ terrorist incidents. The coefficient of the first lag of Δ terror incidents is statistically significant at 1 % level. In case of Δ GDPPC, the coefficient signs of both first and second lag of Δ GPP are negative and statistically significant at 10% and 1%, respectively. The result can be summarized as:

1) 1 point increase in Δ terror incidence $_{t-1}$ increases Δ terror incident by 0.587 point.
2) 1 point increase in economic growth$_{t-1}$ reduces Δ terror incidents by 0.200 point while 1 point increase in economic growth $_{t-2}$ reduces Δ terror incidents by 0.329 points.
3) The coefficients of both lags of Δ poverty rate are statistically insignificant. However, since the coefficient sign of the first lag is positive, we can at least infer that an increase in Δ poverty rate$_{t-1}$ is related with an increase in terrorist incidents in the following year.

VAR model calls for extra caution in choosing the maximum lag p because accurate inference depends on the correctness of the selected lag order. Prior to estimation, we used "the lag selection-order criteria process" to infer how many lags should be used for the VAR model. Upon applying the selection-order criteria test, which gives information on various relevant criteria such as AIC[1], HQIC[2] and SBIC[3], we selected lag 2 (See table 2).

[INSERT TABLE 2]

To run VAR, we need to make sure all the variables are I(0) (stationary), in other words, there should be no unit root. To ensure this, we conducted Granger Causality (1987) Wald Tests, which should be done after VAR. In those tests, 3 variables are assumed to be stationary or have no unit root. The aim of the test is to check whether H_0[4] - the null hypothesis - can or cannot be rejected. For the Δ Terror Incidents model, the result indicates that the null hypothesis is rejected at 5% significance level. Therefore, "variables do Granger-cause the others" at 5% significance level and we can run the VAR for Δ Terror Incidents model.

[INSERT TABLE 3]

We also applied the Johannsson test of co-integration (1988) where all the variables are assumed to be I(d) (non-stationary) with $d > 0$. The main rationale for this test is that when variables are differenced, they become stationary. If the variables are co-integrated, then the error correction term has to be included in the VAR and in this case, the model becomes a Vector Error Correction Model (VECM).[5] The Johannsson co-integration test result indicates that there is co-integration of rank 1. This means that three variables are long-run associated, which means that our model too should be VECM.[6] (See table 4). We do not report the VECM estimation result because the main objective of our estimation is to confirm whether our proposed TAVE model can track real world events.

[INSERT TABLE 4]

[1] Akaike information criterion

[2] Hannan-Quinn Information Criterion

[3] In statistics, Schwarz criterion (also SBC, SBIC) is a criterion for model selection among a finite set of models. It is based, in part, on the likelihood function and it is closely related to the Akaike information criterion (AIC).

[4] Here the null hypothesis is 'var1 does not Granger-cause var2'.

[5] VECM can be seen as a restricted of VAR

[6] We did not report the estimation result of VECM here because the main objective of our estimation here is to cross check if the proposed TAVE model can actually reflect the real world event.

7. Concluding Observations and Policy Implications

Terrorist attacks can have significant negative effects on economic performance but measuring this impact with any degree of certainty is inherently challenging. In addition, while there is a wide range of factors which give rise to terrorism, economic factors also play a role. In this paper, we propose a new model for evaluating the economic impact of a terrorist attack. The terrorist attack vulnerability evaluation model (*TAVE-Model*) examines the evolution of terrorist attack in three different phases: (i) origins of a terrorist attack; (ii) terrorist attack; (v) the post-terrorist attack effect. The *TAVE-Model* relies on indicators such as economic desgrowth ($-\delta$), intensity of terrorist attack (α_i), terrorist attack losses ($-\pi$), economic wear (Π) due to an attack, level of terrorist attack tension (ζ), level of negotiation (η) and total economic leaking (Ω_t) due to an attack.

The underlying intuition is that the economic impact of a terrorist attack depends on a country's vulnerability to attacks from domestic and international terrorist groups, which jointly determines the leakage from economic growth ($-\delta$) and hence the impact on growth. We hope that the *TAVE-Model* will contribute to a better and deeper understanding of measuring the effects of a terrorist attack on civil society from an economic perspective. The *TAVE-Model* shows that if the real GDP growth rate (ΔO_r) is small, then the total economic leaking (Ω_t) due to an attack will always affect economic performance. At the same time, this economy will experience permanent economic desgrowth ($-\delta$). On the other hand, if the real GDP growth rate (ΔO_r) is high, then total economic leaking (Ω_t) due to a terrorist attack will have a more limited impact in the beginning stage. Total economic leaking (Ω_t) will cause economic desgrowth ($-\delta$) only at a later stage.

Furthermore, in the stage of terrorist attack, economic wear (Π) from a terrorist attack is determined by four variables, namely economic desgrowth ($-\delta$), terrorist attack losses ($-\pi$), total economic leaking (Ω_t) due to a terrorist attack, and the intensity of terrorist attack (α_i). In fact, it is possible to appreciate how terrorist attack losses ($-\pi$) and economic leaking (Ω_t) due to an attack can directly affect economic wear (Π). Our analysis shows that large terrorist attack losses ($-\pi$) and a high intensity of terrorist attack (α_i) volumes will lead to large total economic leaking (Ω_t) and economic desgrowth ($-\delta$).

The recovery process of player 1 (P_1), in its economic desgrowth ($-\delta$), will depend on the magnitude (Δ) of the terrorist attack., as well as real GDP growth rate (ΔO_r), total economic leaking (Ω_t), and magnitude of terrorist attack losses ($-\pi$). We hope that the *TAVE-Model* can inform and guide policymakers to better prepare for and cope with the economic consequences of terrorist attacks. Of course, we cannot and should not ignore the non-economic cost of terrorism, such as loss of human life, physical injury, and general psychological fear. At the same time, while economic cost is clearly not the only cost of terrorist attacks, it is an important cost which should enter into the calculus of policymakers when they decide how much to invest and in which areas to invest, both to prevent terrorism and to minimize the economic damage from terrorism once it occurs.

The quantitative estimates of the economic cost of terrorism generated by our model should give policymakers at least some rough clues about what is at stake economically in the event of a terrorist attack. Furthermore, at a broader level, perhaps the best way to nip terrorism in the bud is pursuing policies which are conducive for economic growth. Our econometric analysis of Pakistan indicates that a strong economy is a powerful antidote to terrorism. Better military and civilian intelligence will also help, as will effective poverty eradication programs that render poorer Pakistanis less susceptible to the ideological propaganda of extremist groups. Furthermore, a stronger and more impartial justice system will promote social justice and thus mitigate the social grievances of disadvantaged and marginalized Pakistanis who provide fertile recruiting grounds for terrorist groups looking for foot soldiers. To conclude, while terrorism in Pakistan is a multidimensional issue, we hope that our analysis through the prism of the TAVE-Model can contribute toward a better and richer understanding of its causes and consequences.

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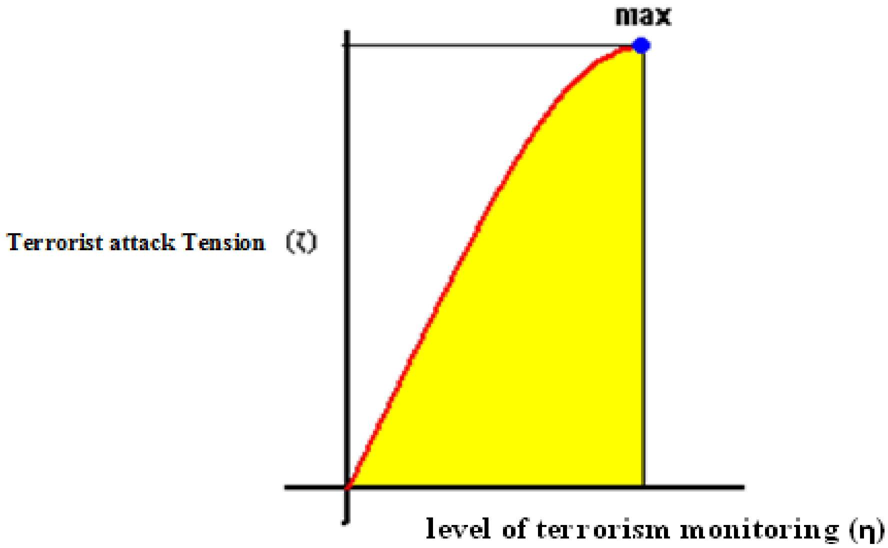
Figure 1

The Relationship between Terrorist attack Tension (ζ) and Level of Terrorist attack Monitoring (η)



Source: Ruiz Estrada (2012)

Table 1 Vector Auto Regression Estimates[7]

Parameters	Δ Terrorist Incidence	Δ GDP Per Capita	Δ Poverty Rate[8]
Δ Terror Incidence $_{t-1}$	0.587*** (3.100)	-0.042 (0.580)	-0.219 (-1.360)
Δ Terror Incidence $_{t-2}$	0.215 (1.020)	0.446 (0.140)	0.398* (2.230)
Δ $GDPPC_{t-1}$	-0.200* (-1.890)	0.148 (-0.370)	0.021 (0.240)
Δ $GDPPC_{t-2}$	-0.329*** (-3.150)	0.035 (0.180)	0.109 (1.230)
Δ Poverty Rate $_{t-1}$	0.572 (0.900)	-0.568 (-0.370)	-0.260 (-0.480)
Δ Poverty Rate $_{t-2}$	-0.361 (-0.610)	0.258 (0.180)	1.168* (2.310)
CONSTANT	-0.778 (-0.300)	6.454 (1.050)	4.342 (2.010)
R^2	0.975	0.146	0.987
RMSE	2.475	5.943	2.094
P>F	0.000	0.792	0.000
Log likelihood	-178.904		
Det (sigma_ml)	329.855		

Note 1: sample period::1989-2013, Number of observation :25

Note 2: legend: * p<.05; ** p<.01; *** p<.001 and t value in parentheses

The estimated result can be written as[9]

$$\Delta \text{ Terror Incident} = -0.778 + 0.587^{a}\,\Delta \text{ Terror Incident}_{t-1} + 0.215\,\Delta \text{ Terror Incident}_{t-2} - 0.200\,\Delta\, GPP^{c}_{t-1} - 0.329\,\Delta\, GPP^{a}_{t-2} + 0.572\Delta \text{ Poverty Rate}_{t-1} - 0.361\Delta \text{ Poverty Rate}_{t-2}$$

[7] We add commands of "dfk" and "small". "dfk" specify that a small-sample degrees-of-freedom adjustment be used when estimating Σ, the error variance–covariance matrix. And "small" causes VAR to report small-sample t and F statistics instead of the large-sample normal and chi-squared statistics.(directly quoted from STATA program user guideline)

[8] We used the 'absolute poverty'.- less than one dollar per day.

[9] The superscripts [a b c] indicates significant probabilities p<.001, p<.01, p<.05 respectively.

Table 2 Selection-order criteria[10]

Pre-selection								
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-236.445				221423.000	20.821	20.859	20.969
1	-178.037	116.820	9	0.000	3047.440	16.525	16.674	17.1174*
2	-166.335	23.405*	9	0.005	2530.29*	16.29*	16.5507*	17.327
3	-157.937	16.796	9	0.052	3025.070	16.342	16.715	17.823
4	-150.401	15.072	9	0.089	4480.620	16.470	16.954	18.395
Post-selection								
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-257.098	0.000	0	0.000	218455.000	12.054	12.054	12.054
1	-191.430	131.340	9	0.000	2366.400	7.521	7.643	7.9596*
2	-178.904	25.054*	9	0.003	1853.34*	7.23865*	7.48206*	8.116

Note 1 : *Specifies that criteria is suggesting to choose the lag of the same column. According to our result, four criterion are suggesting us to choose the lag (2) because here “majority must be granted”.

Note2: After VAR estimation, we can see that model fitness has been improved as the criterion such as the values of AIC, HAIC and SBIC have been reduced.

[10] Choosing maximum lag p is required for VAR, VECM and Johansen tests for cointegration because all these models are system equation model.

Table 3 Granger Causality Wald Tests

Equation	Excluded	F	df	df_r	Prob > F
Δ Terror Incident	Δ GDPPC	6.899	2	18	0.006
Δ Terror Incident	Δ Poverty Rate	1.580	2	18	0.233
Δ Terror Incident	ALL	3.834	4	18	0.020
Δ GDPPC	Δ Terror Incident	0.929	2	18	0.413
Δ GDPPC	Δ Poverty Rate	0.589	2	18	0.565
Δ GDPPC	ALL	0.568	4	18	0.689
Δ Poverty Rate	Δ Terror Incident	2.754	2	18	0.091
Δ Poverty Rate	Δ GDPPC	0.798	2	18	0.466
Δ Poverty Rate	ALL	1.929	4	18	0.149

Table 4 Johansen Tests for Cointegration

maximum rank	parameters	LL	eigenvalue	trace statistic	5 % critical value
0	12	-196.312	.	34.817	29.680
1	17	-185.859	0.567	13.9110*	15.410
2	20	-180.220	0.363	2.632	3.760
3	21	-178.904	0.100		
maximum rank	parameters	LL	eigenvalue	max statistic	5 % critical value
0	12	-196.312	.	20.907	20.970
1	17	-185.859	0.567	11.279	14.070
2	20	-180.22	0.363	2.632	3.760
3	21	-178.904	0.100		

Note: When trace (max) statistics are bigger than the critical value, the null hypothesis that there are no (rank) cointegration in variables cannot be rejected. Our model rejects the null at rank 1 thus we can assume that our variables are long run associated or moving together.