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# **The Effects of Terrorist Activities on Foreign Direct Investment: Nonlinear Evidence**

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## **Abstract**

In this study, we examine the relationship between foreign direct investment and terrorist incidents that took place in Turkey for the period from 1991:12 to 2003:12. This research contributes to the literature by checking for a possible non-linear relationship between terrorism and foreign direct investment. The data used to measure the intensity of terrorism were collected from the newspapers of Turkey, and therefore are limited to the direct signals given to the market. Empirical evidence from both linear and non-linear models confirms that terrorism has a large significant negative impact on foreign direct investment. With respect to the nonlinear model, the impact of terrorism on the foreign direct investment is more severe during periods of high terrorism when the intensity of terrorism passes the threshold level 3.725.

*Keywords:* Terror, FDI, Smoot Transition Model

*JEL Classifications:* F21, J18, C22

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## Introduction

In this paper, we investigate the economic costs of terrorist activities on foreign direct investment (FDI). Thus, we explore whether terrorist incidents can deter foreign direct inflows through an atmosphere of threats and heightened financial risks. The paper has three primary purposes. The first one is to understand whether the relationship between terror and FDI is significant for Turkey or not. The second one is to investigate whether the relationship between these variables is linear or nonlinear. Finally, we aim to obtain a specific threshold level if the relationship between FDI and terrorist activities is nonlinear. Nonlinearity has important implications with respect to the economic and political costs. The policy makers can learn and revise their policies with respect to the relationship between the aforementioned variables, if they know a specific threshold value. To understand the political and economic costs of terror, it is important to determine whether terrorist campaigns force sufficient political and economic costs on a government so that it concedes to the political demands of the terrorists. Terrorist-imposed economic costs may stem from at least four sources; losses from tourism revenues, losses from foreign direct investment, destruction of infrastructure, and finally resources used to deter terrorist attacks (Enders and Sandler, 1996). If the expected costs combined with a terrorist movement do not exceed the expected costs associated with making awareness, then the government should maintain its position. Otherwise, the government should negotiate or else allocate sufficient resources to nullify the threat. At this point, it is important to know the threshold level which is a by-product of the nonlinear models. This threshold level gives very significant information to policy makers where the terrorist activities have lower effects on FDI below the threshold level and more vice versa. Therefore, the information provided by a nonlinear model can influence the policy maker's decision notably. If the intensity of terrorism is below the threshold level, then terror can be taken as a noncredible threat and the government will hold its position or vice versa. On the other hand, the threshold obtained from the nonlinear regression model has also important signals for foreign investors. The relatively less-informed foreign investors can use this threshold level in making their investment decisions<sup>4</sup>.

One should also be careful in drawing conclusions regarding mutual causality between FDI and economic variables. Some studies have also examined the other causal direction; i.e. from economic activity to terrorism (Abadie, 2006; Santos Bravo and Mendes Dias, 2006), or both causal directions (Enders and Sandler, 1991, Araz *et al.* 2010). Eckstein and Tsiddon (2004) used a VAR analysis of Israeli data to show that terror has significant and detrimental short-term effects on major macroeconomic variables such as consumption, investment and net exports. It has also been argued that terrorism has longer-term effects on the economy. Blomberg *et al.* (2004) used a set of unbalanced panel data to show that terrorism has a negative effect on long-term economic growth. Abadie (2006) showed that countries in some intermediate range of political freedom are shown to be more prone to terrorism than countries with high levels of political freedom, or countries with highly authoritarian regimes. His results suggest that transitions from an authoritarian regime to a democracy may be accompanied by temporary increases in terrorism. Santos Bravo and Mendes Dias (2006) showed that the number of terrorist incidents is negatively associated with the level of development, the literacy level and ethnic fractionalization, being positively related to mineral reserves, non-democratic political regimes and participation in

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<sup>4</sup> Using this methodology one can organize country risk indexes. However, we have no opportunity to obtain the terror data of other countries.

international organizations. Similarly, Rübhelke (2005) used a game theoretical framework to analyze terrorist activities, and submitted several options in his study to combat terrorism. He found that mitigating the income of social groups susceptible to terrorism in response to terrorist attacks reduces the level of terrorism, whereas it may also increase the terrorists' willingness to commit suicide attacks. Enders and Sandler (2005) used a threshold autoregression (TAR) model to show that the autoregressive nature of casualties from terror depends on the level of terrorism at the time of a shock. In their study, the TAR model outperforms a standard autoregressive representation. Araz *et al.* (2009) used a Nonlinear ST-VAR analysis of Turkey data to show that terror has significant and detrimental short-term effects on long-term economic growth. They have tested linear VAR versus nonlinear ST-VAR model and concluded that the nonlinear ST-VAR model is superior to linear one. Hence, one might argue that the terrorism variable can be better investigated by using non-linear models. Moreover, other studies show that non-linear models outperform linear models with respect to economic activity. For instance, Potter (1995) and Pesaran and Potter (1997) applied threshold autoregressive (TAR) models to find evidence of asymmetric effects of shocks over the business cycle. Similarly, Teräsvirta and Anderson (1992) and Teräsvirta (1994) tested linearity against smooth transition autoregressive (STAR) models and provided support for autoregressive representation.

This study contributes to the literature in three different ways. First, a novel data set is used for Turkey which signals the market directly. Consistent with Abedie (2006), Turkey has experienced a considerable increase in the level of domestic conflict during its trade liberalization process, which started in the early 1980s. The existence of continuous terrorist activities up to today provides excellent position for investigating the effects of terrorism on FDI. Second, by incorporating the results of studies such as Araz *et al.* (2010), Enders, and Sandler (1992, 2005) into the analysis, it is hypothesized that the relationship between terrorism and economic activity is nonlinear. By using this nonlinear model, we estimate threshold level of terrorist activities which affects FDI more accurately. The estimated threshold level has two important implications, one for policy makers and the other for foreign direct investors. Therefore, we analyze this issue extensively. Finally, we provide a simple economic model of nonlinear relationship between FDI and terrorist activities.

The remaining of the paper is organized as follows. In section 2, we give a brief history of terrorist activities and FDI for Turkey. Section 3 discusses the underlying economic model. In section 4, we discuss specification and estimation of STR models and give the results of the linearity tests against STR-type nonlinearity. The estimates of linear and STR models are provided in section 5. Section 6 is the conclusion.

## **2. Brief History of Terrorism and FDI for Turkey**

Turkey's history of terrorism can be classified in two periods: period before September 12, 1980 and afterwards. The terrorist activities occurred before 1980 can be defined as the actions that are fundamentally ideological. Clash of different ideological groups in the country, initially started as a conflict between right-wing and left-wing students, but later spread in waves, covering the whole country turned into terrorist attacks. The aim of the

terrorist activities of the aforementioned period was to replace the existing constitutional order.

The second period constitutes the subject of our study. This period beginning from August 14, 1984, includes the terrorist activities that differ significantly from 1980 pre-term actions. Segregation of these two periods is based on the area covered by the terrorist activities, definition of terrorism and the purpose of terrorism. PKK-separatist terrorist organization initiated acts of terrorism in East and Southeast Anatolia in 1984, and the actions continue for many years. These terrorist incidents resulted in deaths of tens of thousands, and the incidents continue. When compared to the other regions of Turkey, East and Southeast Anatolia regions have three distinct features: the people of these regions have a different ethnic structure; the regions are composed of people that are mainly of Kurdish origin; and these two regions have a lower level of economic development. These three features are among the main reasons of PKK terrorism in these regions. Moreover, Araz *et al.* (2009) showed that the number of terrorist incidents is negatively associated with the level of economic growth for Turkey with the similar data. Thus, increasing income levels of these regions lead to a substantial decline in terrorist activities.

There is an unequal income distribution in Turkey especially with respect to these two regions. The presence of these differences is a well-known fact that causes separatist movements. In western regions of Turkey, per capita GDP (Gross Domestic Product) value is well above national average, while this value of eastern regions of Turkey is below the national average. From Table 1 and Table 2 we can observe these facts clearly.

**Table 1. GDP Shares of the regions**

Marmara	E. Anatolia	Mediterranean	S. Anatolia	Aegean	Black Sea	C.Anatolia
37%	3.3%	11.9%	5.2%	17.1%	9.3%	15.7%

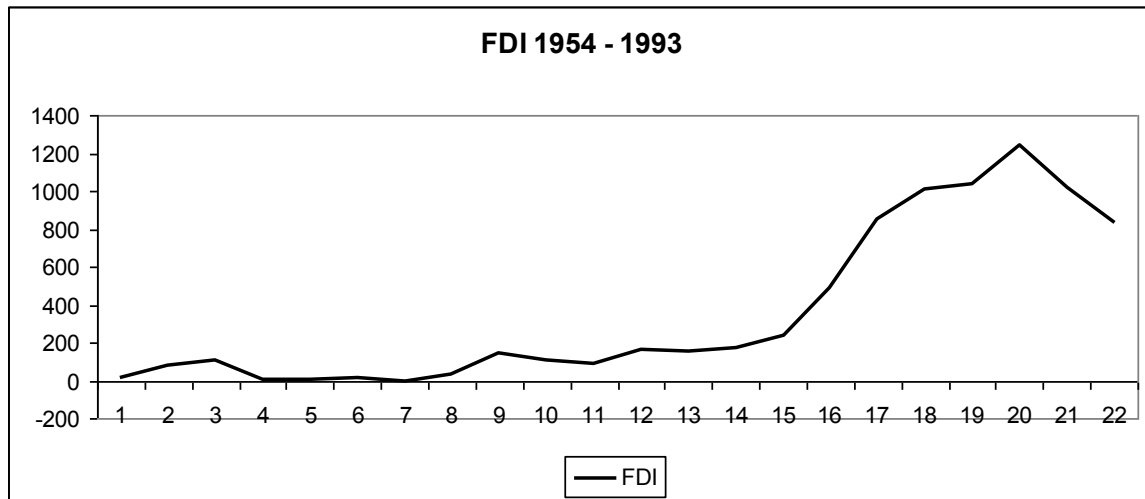
- Constant price 1996

**Table 2. Number of Households and available income distribution by the Regions**

	Turkey	Regions						
		Marmara	East Anatolia	Mediterranean	South E. Anatolia	Aegean	Black Sea	Central Anatolia
Households Available	100.0	26.6	15.7	12.5	17.9	12.8	7.1	7.4
annual income	100.0	38.6	13.9	11.0	15.4	10.9	5.7	4.5

- Constant price 1996

After the financial liberalization during the 1980, there existed an increase in FDI for Turkey. This process continued until 1992 when the political instability took place because of coalition governments. During the 90's, these coalition governments ruled the Turkish political environment and caused inefficiencies in the economic performance of Turkey. Especially the bad economic performance prevented foreign investors from investing in Turkey which means that the FDI values have decreased after 1992. In 1992 the permits which were given to FDI decreased 7.5 percent with respect to the previous year and the value of the FDI were 1.967 billion dollars and 1.820 billion dollars, respectively. In Figure 1 below we can trace the yearly volume of FDI from 1954 to 1993 when the empirical sample period started.



**Figure 1. Yearly FDI between 1954 and 1993**

On the other hand, the percent of FDI inflows has to be analyzed with respect to country groups. From Table 3 we can see some summary figures of FDI for Turkey with respect to these countries. Table 3 compares 1996 and 2000 figures of FDI which cover the mid sample period of empirical analysis. We see that Turkey attracts FDI from west Europe extensively.

**Table 3. FDI figures of Turkey comparing year 1996 and 2000**

Countries	Num of firms		Value		Percent%		Total Capital	
	1996	2000	1996	2000	1996	2000	1996	2000
Holland	173	345	14.870	282.686	14.8	21.91	22.778	469.433
France	192	255	13.650	163.803	13.6	12.70	23.241	296.881
Germany	620	932	13.044	160.811	13.0	12.46	27.480	256.817
US	245	325	12.645	158.696	12.6	12.30	19.044	282.175

Resources: \*1996 FDI, DPT, 1997 year program, pp. 154.

\*2000. Treasury; <http://www.treasury.gov.tr/stat/yabser/ulketurk.htm>

\* Figures are given in Billion TL

**Table 4. Sectoral Distribution of FDI Companies**

Sectors	Num of firms		Value		Percent%		Total Capital	
	1996	2000	1996	2000	1996	2000	1996	2000
Agriculture	84	125	771	11162	0.8	0.87	1,982	23,139
Mining	47	74	713	10536	0.7	0.82	1,335	20,056
Manufacture	876	1312	51,163	592,452	51.0	45.95	105,604	1,170,638
Service	2456	3717	47,637	675,249	47.5	52.37	81,446	1,231,986
Total	3463	5228	100,285	1,289,399	100.0	100.0	190,367	2,445,821

Resources: \*1996 FDI, DPT, 1997 year program, pp. 155.

\*2000. Treasury; <http://www.treasury.gov.tr/stat/yabser/ulketurk.htm>

\* Figures are given in Billion TL

In 1993 FDI tends to increase when the value of FDI reaches to 2.124 billion dollars. Unfortunately, in 1994 Turkish economy experienced a heavy economic crisis which decreased the FDI level to 1.484 billion dollars, this sharp drop from 1993 to 1994 is

nearly 30% percent. This sharp fall was followed by a recovery in FDI figures and every aspect of economic indicators as well after 1994. In 1995 FDI faced with a peak value in percentage change in the history of the Turkish economy which is 97.91%. Therefore, this increase lead to 2.938 billion dollars FDI value for this year. For 1996 there was a 30.5 % percent increase with respect to the previous year which lead to 3.836 billion dollars FDI value. The Turkish economy had affected from 2 more economic crises until 2003, one of which was Russian crisis and the other one was 2001 crisis. From the figures of FDI, we have seen that these crises had detrimental effects on FDI.

### 3. Theoretical Model

We have used Ragnar-Frisch type of model in order to explain the non-linear relationship between FDI and terrorist activities. The model implicitly assumes that terrorist activities have impacts on FDI but there is no causality relationship from FDI to terrorist activities. Therefore, there is uni-directional causality in theoretical modeling. In the model we have foreign investors and nature which is determined by terrorist activities. We view foreign direct investors as rational actors who maximize their well-being by allocating their resources intertemporally. At time 0, we consider a foreign investor who tries to allocate his wealth between riskless domestic bonds and FDI index contingent upon the states of the world at time t. There are two possible future states of the world with probabilities q and 1-q respectively where  $q \in [0,1]$ . When state 1 occurs, there is a terrorist activity which derives the value of the market portfolio (the index) down significantly, hence making FDI less profitable than riskless domestic government securities. When state 2 occurs, the terrorist activity has no significant impact on index rendering the returns from FDI higher than riskless bonds.

Let  $C_{t1}$  consumption of the investor at time t in state 1,  $C_{t2}$  consumption of the investor at time t in state 2,  $e_{t1}$  wealth of consumer when state 1 occurs,  $e_{t2}$  wealth of consumer when state 2 occurs. Assuming that there is no consumption at t=0, let the representative investor have the following utility function:

$$U ( C_{t1}, C_{t2} ) = q \ln(C_{t1}) + (1-q) \ln(C_{t2}) \quad (3.1)$$

Now the representative investor solves

$$\text{Max}_{C_{t1}, C_{t2}} q \ln(C_{t1}) + (1-q) \ln(C_{t2}) \quad (3.2)$$

subject to

$$C_{t1} + C_{t2} = e_{t1} + e_{t2} \quad (3.3)$$

Direct substitution yields:

$$\text{Max}_{C_{t1}} q \ln(C_{t1}) + (1-q) \ln ( e_{t1} + e_{t2} - C_{t1} )$$

First order condition gives:

$$\frac{q}{C_{t1}} + \frac{1-q}{e_{t1} + e_{t2} - C_{t1}} = 0 \quad (3.4)$$

$$\Rightarrow C_{t1} = \frac{q(e_{t1} + e_{t2})}{2q-1}$$

and from the budget constraint we have

$$C_{t2} = \frac{(q-1)(e_{t1} + e_{t2})}{2q-1} \quad (3.5)$$

hence the investor's optimal utility becomes

$$U = q \ln \frac{q(e_{t1} + e_{t2})}{2q-1} + (1-q) \ln \frac{(q-1)(e_{t1} + e_{t2})}{2q-1} \quad (3.6)$$

For the case  $e_{t1} + e_{t2} = 1$  showing us that up to a certain  $q$  between 0 and 1 the utility is increasing and begins to decrease beyond that  $q$  which is the probability of a terrorist attack, rendering FDI unprofitable for the investor. For the values other than 0, 1 closed interval there is no significance. We always encounter similar behaviors for other values, demonstrating us that there is indeed a transition point altering the decision of the foreign investor which we can define this point as threshold level. Equation (3.6) shows us a behavioral equation of representative foreign direct investor hence this leads to a functional relationship between FDI and terror as follows:

$$FDI_t = f(Terror_{state1}, Terror_{state2}, X_t^{st1}, X_t^{st2}, FDI_{t-i}^{st1}, FDI_{t-i}^{st2}), \quad i = 1, \dots, p \quad (3.7)$$

This general form of FDI equation is specific to one country which has faced these types of representative FD investors or agents.  $Terror_{state1}, Terror_{state2}$  are representing the nature of the economy hence there occurs two types of distinct regimes in the economy,  $X_t^{st1}$  and  $X_t^{st2}$  represent the other factors which are affecting the volume of FDI including crises dummies,  $FDI_{t-i}^{st1}$  and  $FDI_{t-i}^{st2}$  represent the lagged values of FDI in two regimes, respectively. All the other variables are again depending upon states except crisis dummies. From this general functional form, we can affirm that instead of linear modeling a nonlinear modeling is more suitable. Therefore, we have to prefer one of the nonlinear modeling in the literature like Markov Switching, TAR or STR in order to estimate equation (3.7). These models have their own advantages over each other. In our case, Markov switching model seems to be more suitable because we explicitly define states and their probabilities. However, Markov switching models have some obstacles for our situation. First, Markov switching models impose an abrupt switch in parameter values where we are not expecting this kind of dynamic in between the FDI and terror relationship. Second, Markov switching models estimation procedure does not provide any kind of threshold level which we want to estimate a threshold level as an indicator for policy purposes. Finally, Markov switching model has a hidden process where the STR model allows for different types of market behaviour depending on the nature of the transition function.

Because of these arguments we consider smooth-transition autoregressive models (originally proposed by Chan and Tong, 1987 as a generalization of the threshold autoregressive (TAR) model, and developed further by Teräsvirta and Anderson, 1992, Granger and Teräsvirta, 1993, Teräsvirta, 1994) which are capable of capturing the



nonlinear behaviour arising from the state of the market (i.e. differing dynamics depending on whether the market is rising or falling<sup>5</sup>). The smooth-transition model is selected for a number of reasons. First, it is theoretically more appealing over the simple threshold and Markov switching models which impose an abrupt switch in parameter values. Such instantaneous changes in regimes are possible only if all agents act simultaneously and in the same direction. For the market of many traders acting at slightly different times, however, a smooth transition model is more appropriate. From Section 2, we have seen that there are different foreign direct investors, which lead to a heterogeneous structure of FD investors. On the other hand the terrorist activities are ex-post phenomenon which occurs after some FDI agreement has taken place. Therefore, most of the investors do not have any initiative to invalidate the current agreements which they have signed (ex-ante) before any terrorist activity. However, some of them do. If these terrorist activities continue, there will be a gradual decline in FDI. Hence, this type of behaviour causes a smooth transition from one regime to other, on the contrary of abrupt regime shifts as well. Second, the STR model allows for different types of market behaviour depending on the nature of the transition function. Finally, STR model allows explicit estimation of threshold value for an indication of policy issues.

#### 4. Specification and Estimation of STR Models

A STR model for a time series  $y_t$  is given by

$$y_t = \pi_{1,0} + \pi_1' x_t + (\pi_{2,0} + \pi_2' x_t) \cdot F(s_t; \gamma, c) + u_t \quad (4.1)$$

where  $x_t$  is a vector consisting of lagged values of the endogenous variable and other endogenous variables. The disturbance  $u_t$  is white noise with zero, and is assumed to be homoscedastic over regimes with variance  $\sigma^2$  and to be normally distributed. The transition function  $F(s_t; \gamma, c)$  is a continuous function bounded between 1 and 0. Thus the STR model can be interpreted as a regime-switching model that allows for two regimes, associated with the extreme values of the transition function,  $F(s_t; \gamma, c) = 0$  and  $F(s_t; \gamma, c) = 1$ , whereas the transition from one regime to the other is gradual. The parameter  $\gamma$  determines the smoothness of the transition, and thus, the smoothness of transition from one regime to the other. The two regimes are associated with small and large values of the transition variable  $s_t$  relative to the threshold  $c$ .

Two popular choices of the transition function  $F(s_t; \gamma, c)$  are the logistic function

$$F(s_t; \gamma, c) = \frac{1}{1 + \exp(-\gamma(s_t - c) / \sigma_{s_t})} \quad (4.2)$$

And the exponential function

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<sup>5</sup> In our case if there is a threat of terrorist activity or not.

$$F(s_t; \gamma, c) = 1 - \exp(-\gamma(s_t - c)^2 / \sigma_{s_t}^2) \quad (4.3)$$

where  $\sigma_{s_t}$  is sample standard deviation of the transition variable  $s_t$ .

These yield, respectively, the logistic STR (LSTR) and exponential STR (ESTR) models. The logistic function is convenient for modeling different dynamics depending on whether the terrorist activity take large or small value, i.e., the direction of disequilibrium. Thus, the LSTR model can describe a situation where low terrorist activity and high terrorist activity periods have rather different dynamics. In contrast, the transition occurs symmetrically for  $s_t$  about threshold  $c$  if exponential function is used in (4.1). The ESTR model implies that low terrorist activity and high terrorist activity periods have similar dynamics (see Teräsvirta and Anderson, 1992).

The empirical specification procedure for STR models consists of following steps (van Dijk, 1999:18):

1. Specify an appropriate linear autoregressive model for the time series under investigation.
2. Test the null hypothesis of linearity against the alternative of STR-type nonlinearity. If linearity is rejected, select the appropriate transition variable  $s_t$  and the form of the transition function  $F(s_t; \gamma, c)$ .
3. Estimate the parameters in the selected STR model.
4. Evaluate the model using diagnostic tests.
5. Modify the model if necessary.
6. Use the model for descriptive or forecasting purposes.

Since the nonlinearity tests are sensitive to autocorrelation, the lag structure of the autoregressive model should be specified so as to capture the significant autocorrelation in the linear model. Applying conventional information criteria such as Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC) can be selected the lag structure of the model.

Once the appropriate linear model is defined, we carry out linearity tests against the alternative STAR-type nonlinearity. The linearity tests are complicated by the presence of unidentified nuisance under the null hypothesis. This can be seen by noting that the null hypothesis of linearity may be expressed in different ways. Besides equality of the parameters in the two regimes,  $H_0 : \pi_1 = \pi_2$ , the alternative null hypothesis  $H_0' : \gamma = 0$  also gives rise to linear model. To overcome this problem, one may replace the transition function  $F(s_t; \gamma, c)$  with appropriate Taylor approximation following the suggestion of Luukkonen et al (1988). For example, a first-order Taylor approximation results in the following auxiliary regression

$$y_t = \beta_{0,0} + \beta_0' x_t + \beta_{1,0} s_t + \beta_1' x_t s_t + e_t \quad (4.4)$$

Where  $\beta_{0,0}, \beta_0', \beta_1'$  are functions of the parameters  $\pi_1, \pi_2, \gamma$  and  $c$ , and  $e_t$  comprises the original shocks  $u_t$  as well as the error term arising from the Taylor approximation. In (2.4) it is assumed that the transition variable  $s_t$  is not one of the elements in  $x_t$ . If this is

not the case, the term  $\beta_{1,0}s_t$  should be dropped from the auxiliary regression. The null hypothesis of linearity can be expressed as  $H_0'' : \beta_1' = \phi_1 = 0$ , that is, the parameters associated with the auxiliary regressors are zero. This null hypothesis can be tested by a standard variable addition test in a straightforward manner. The test statistic, to be denoted as LM1, has an asymptotic  $\chi^2$  distribution with degrees of freedom  $p+1$ , where  $p$  is the dimension of the vector  $x_t$ .

As noted by Luukkonen et al (1988), the LM1 test statistic has no power in situations where only the intercept is different across regimes. Luukkonen et al (1988) offer a remedy for this deficiency by replacing the transition function  $F(s_t; \gamma, c)$  by a third order Taylor approximation instead. This would result in the following auxiliary model

$$y_t = \beta_{0,0} + \beta_0' x_t + \beta_{1,0} s_t + \beta_1' x_t s_t + \beta_{2,0} s_t^2 + \beta_2' x_t s_t^2 + \beta_{3,0} s_t^3 + \beta_3' x_t s_t^3 + e_t \quad (4.5)$$

The null hypothesis now corresponds to  $H_0''' : \beta_i' = 0, i=1,2,3$ , which again can be tested by a standard LM-type test. Under the null hypothesis of linearity, the test statistic, to be denoted as LM3, has an asymptotic  $\chi^2$  distribution with degrees of freedom  $3(p+1)$ . Since only the parameters corresponding to  $s_t^2$  and  $s_t^3$  are functions of  $\pi_{1,0}$  and  $\pi_{2,0}$ , a parsimonious or economy version of the LM3 statistic can be obtained by augmenting the auxiliary model (4.4) with regressors  $s_t^2$  and  $s_t^3$ , that is

$$y_t = \beta_{0,0} + \beta_0' x_t + \beta_1' x_t s_t + \beta_{2,0} s_t^2 + \beta_{3,0} s_t^3 + e_t \quad (4.6)$$

The resultant statistic is the LM3<sup>E</sup> statistic.

To identify the appropriate transition variable  $s_t$ , the LM statistics can be computed for several candidates, and the one for which the p-value of the test statistic is smallest can be selected.

When the appropriate transition variable  $s_t$  has been selected, the next step in specification of a STR model is to choose between logistic and exponential functions. Terasvirta (1994) suggests using a decision rule based on a sequence of tests in equation (4.5). Particularly, he proposes to test the following null hypotheses

- i)  $H_{03} : \beta_3 = 0$
- ii)  $H_{02} : \beta_2 = 0 | \beta_3 = 0$
- iii)  $H_{01} : \beta_1 = 0 | \beta_3 = \beta_2 = 0$

in (4.5) by means of LM type tests. These hypotheses are tested by ordinary F tests, to be denoted as F3, F2, and F1, respectively. The decision rule is as follows: If the p-value corresponding to F2 is the smallest, then ESTAR model should be selected, while in all other cases LSTR model should be preferred.

Once the transition variable and form of the transition function are selected, the STR models can be estimated by using any conventional nonlinear optimization procedure. The burden on the optimization algorithm can be alleviated by using good starting values. For

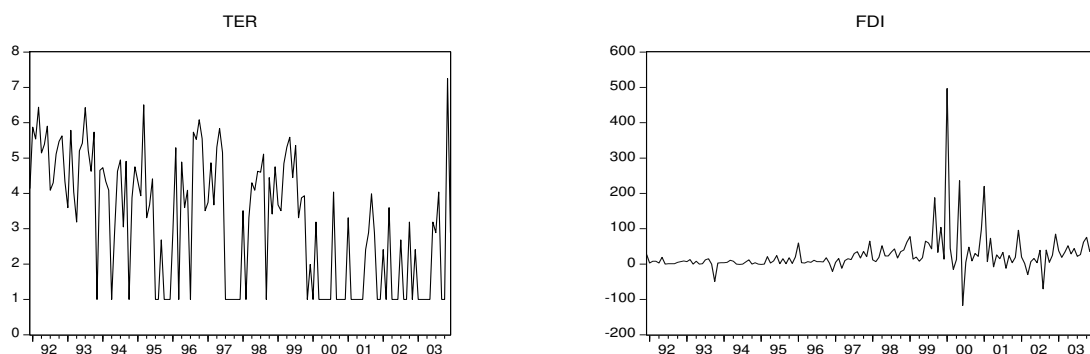
fixed values of the parameters in the transition function,  $\gamma$  and  $c$ , the STR model is linear in parameters  $\pi_{1,0}$ ,  $\pi_1'$ ,  $\pi_{2,0}$  and  $\pi_2'$ , and therefore, can be estimated by OLS. Hence, a convenient way to obtain sensible starting values for the nonlinear optimization algorithm is to perform a two-dimensional grid search over  $\gamma$  and  $c$ , and select those parameter estimates that minimize variance of the residual term.

After estimation, we perform diagnostic tests to evaluate the estimated STR model. Particularly, we perform misspecification tests for skewness and kurtosis, as well as the autoregressive conditional heteroskedasticity (ARCH) test of Engle (1982), and the LM tests for autocorrelation, parameter constancy, and additive nonlinearity, as suggested by Eitrheim and Terasvirta (1996). If the estimated model passes all misspecification tests, then it can be used for descriptive purposes.

## 5. Data and Empirical Results

In this paper, we consider monthly terror index and FDI for Turkey, covering the period from 1991:12 to 2003:12. The FDI data are taken from electronic data distribution system of the Central Bank of Republic of Turkey. On the other hand, the terror index composed by collecting data from newspaper. For this purpose, the data series for the terror index is obtained from the archives of the leading Turkish newspaper, *Hurriyet*. Official statistics of the government have not been used to identify the publicly announced events, which have an effect on the behavior of economic agents<sup>6</sup>.

Following Eckstein and Tsiddon (2004), the terror index used in this paper is defined as the natural log of (1+ number of human casualties + the number of people injured + the number of terrorist attacks) for each month, for the period from 1991:12 to 2003:12. Nevertheless, the empirical results are robust to the use of an alternative terror index, which incorporates the log of the number of casualties. The terror index and FDI figures are presented in Figure 2.



**Fig 2. The Relationship between Terror and FDI**

<sup>6</sup> We assume that only publicly announced events in the media might have an effect on economic agents.

All the asymptotic theory for the STR models is for stationary regressors up to deterministic time trend which has also been studied explicitly. Therefore, the specification procedures described in the previous section rely on the assumption that the FDI and terrorist activity index are  $I(0)$  process. In order to analyze this fact, we first test whether the data have unit root by using unit root test up to deterministic time trend, prior to estimation of the linear model. It is well known that conventional unit-root test have low power if the true data generating process is non-linear. Hence, in addition to conventional unit root test ADF, we also applied the non-linear unit root test KSS.

**Table 5.1. Unit Root Tests**

Variables	ADF		KSS	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Terror	-4.345*	-5.345*	-6.713*	-5.082*
FDI	-3.193**	-3.675**	-7.765*	-7.709*

\*, \*\* indicates significance levels of 1% and 5% respectively

The test results examined within the sample derived from the KSS test reject the null hypothesis of unit root at 1 % significance level in the examined series, whereas ADF test reject the null hypothesis at 5% for FDI series when trend included. From the linear and nonlinear unit root test, we can conclude that all of the variables in the study are  $I(0)$ . Thus, we can continue with the linear model estimation. We have first tested the direction of causality and found uni-directional causality from terrorist activities to FDI consistent with our theoretical model. The linear model is initially specified with maximum lag order of 12, with intermediate lags then deleted one by one (starting with the least statistically significant according to the  $t$ -ratio) provided that such deletions reduce the AIC. The estimated linear model for FDI is as follows:

$$dys_t = \alpha + \sum_{i=1}^p dys_t + \sum_{i=1}^r ter_t + \varepsilon_t$$

$$dys_t = 28.498 + 0.403 dys_{t-4} - 4.028 ter_{t-1} \quad (5.1)$$

[9.060]      [0.077]      [2.384]  
(3.145)      (5.204)      (-1.689)

$R^2=0.349$   $DW= 1.944$   $F\text{-test}= 16.266(0.000)$   $ARCH(1)= 0.046(0.829)$   $ARCH(4)= 3.478 (0.481)$   
 $ARCH(8)= 7.163 (0.519)$

The values below the parameter estimates are p-values. Durbin Watson (DW) statistic for no autocorrelation,. ARCH is Engle's (1982) test against conditional heteroscedasticity. The estimated model does not reveal any misspecification<sup>7</sup>. The ARCH test suggests no nonlinearity in the conditional variance. Therefore, we proceed to linearity tests to check for nonlinearities for the model under consideration.

The results of the linearity tests are reported in Table 5.2. As the table reveals, the null of linearity is rejected at conventional significance levels for a number of candidate transition variables. However, the p-values of all LM-type statistics are the smallest for  $Ter_{t-6}$  was considered as a transition variable. Therefore, we focus on this variable hereafter.

<sup>7</sup> We have included crisis dummies for 1994, 1997, and 2001, but we have found that they are not significant. Hence, we did not hold these crisis dummies in model.

**Table 5.2. Linearity Test**

<i>Lag/State variables</i>	<i>ter<sub>t</sub></i>	<i>fdi<sub>t</sub></i>	<i>t</i>
<b>1</b>	12.519(0.000)	3.204(0.005)	
<b>2</b>	0.491(0.813)	12.339(0.000)	
<b>3</b>	11.220(0.000)	2.351(0.034)	
<b>4</b>	6.404(0.000)	1.480(0.189)	
<b>5</b>	6.516(0.000)	3.326(0.004)	
<b>6</b>	12.705(0.000)	2.539(0.023)	
<b>7</b>	8.054(0.000)	2.108(0.056)	2.092(0.0585)
<b>8</b>	9.699(0.000)	1.214(0.302)	
<b>9</b>	6.965(0.000)	3.448(0.003)	
<b>10</b>	8.741(0.000)	0.815(0.560)	
<b>11</b>	3.512(0.003)	2.085(0.059)	
<b>12</b>	4.540(0.000)	5.687(0.000)	

Having selected the most appropriate transition variable we conduct a sequence of F tests described above to determine the form of the transition function. The F statistics and corresponding p-values are reported in Table 5.3. Since the p-value of the F3 statistic is the smallest, we select the logistic function and estimate LSTR model as our theoretical model suggest in section 3.

**Table 5.3. Selection of transition function between LSTAR and ESTAR**

$H_{03} : \beta_3 = 0$	26.622(0.000)
$H_{02} : \beta_2 = 0 / \beta_3 = 0$	7.773(0.000)
$H_{01} : \beta_1 = 0 / \beta_2 = \beta_3 = 0$	0.124(0.000)

For obtaining initial values to facilitate the nonlinear optimization algorithm we have conducted an extensive two-dimensional grid search over  $\gamma$  and  $c$ , ranging  $\gamma$  (after scaling) from 1 to 100 by 0.01 increments and ranging  $c$  from 1.990 to 6.507 by 0.01 increments<sup>8</sup>. Before proceeding to estimation of the LSTAR model using the optimal values of the parameters  $\gamma$  and  $c$  obtained from the grid search, we have deleted intermediate lags one by one (starting with the least statistically significant according to the  $t$ -ratio), if such deletions had reduced the Akaike Information Criteria (AIC), and conducted a new grid search.

We have estimated the model using nonlinear least squares, which is equivalent to quasi-maximum likelihood based on a normal distribution. Under certain (weak) regularity conditions, which are discussed by White and Domowitz (1984) and Pötscher and Prucha (1997), among others, the NLS estimates are consistent and asymptotically normal. The estimated LSTAR model is given in equation (5.2) with transition function in (5.3) below. The exponent in the transition function is divided by the variance of the transition variable in order to make  $\gamma$  scale-free.

<sup>8</sup> We have based our range for threshold value  $c$  on observed range of terror index by discarding the extreme values at each end.

$$dys_t = 27.470 + 0.915 dys_{t-4} - 3.310 ter_{t-1} + G(s_t; \gamma, c) \cdot \begin{bmatrix} -0.447 dys_{t-4} - 2.667 ter_{t-1} \end{bmatrix} \quad (5.2)$$

$$F(s_t; \gamma, c) = (1 + \exp\{-4.001(ter_{t-1} - 3.725)\})^{-1} \quad (5.3)$$

The values below the parameter estimates are p-values. In addition, we have tested the estimated LSTAR model against additive nonlinearity, parameter constancy and remaining nonlinearity as proposed by Eitrheim and Terasvirta (1996). The results of these tests appear in Table 5.4.

**Table 5.4. Diognastic Check for Nonlinear estimation**

Remaining Autocorrelation						Parameter Constancy	Remaining Nonlinearity Transition variable					
l = 1	l = 2	l = 3	l = 4	l = 5	l = 6		d = 1	d = 2	d = 3	d = 4	d = 5	d = 6
0.68	1.59	1.22	0.95	1.14	0.95		1.33	0.08	0.99	0.76	0.62	1.09
(0.40)	(0.20)	(0.30)	(0.43)	(0.34)	(0.46)	0.332	(0.18)	(0.99)	(0.50)	(0.78)	(0.91)	(0.38)
l = 7	l = 8	l = 9	l = 10	l = 11	l = 12		d = 7	d = 8	d = 9	d = 10	d = 11	d = 12
0.84	0.72	0.64	0.57	0.93	1.59	(0.99)	0.69	0.88	0.85	0.70	0.56	0.52
(0.55)	(0.66)	(0.75)	(0.83)	(0.51)	(0.20)		(0.85)	(0.63)	(0.67)	(0.83)	(0.94)	(0.96)

Diagnostic tests are presented in Table 5.4. As it can be seen from the table, diagnostic tests do not show any problems for two-regime STR models. The LM test statistic provides no support for multiple regime STR model which suggests that the fitted model contains no additional nonlinearity. The LM test for parameter constancy and remaining autocorrelation test have the same kind of conclusion. Hence, overall, the estimated LSTAR model is quite satisfactory. Consequently, the predicted STR models can be used to describe the relationship between FDI and terrorist activity.

The estimated value of the slope coefficient  $\gamma$  is equal to 4.001. This suggests that the speed of transition between the two regimes is moderate in line with stylized facts, contrary to the Markov and TAR models, which assume an abrupt change in regimes.

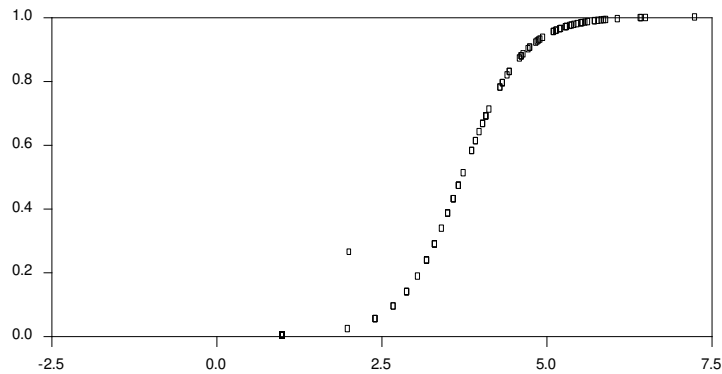


Figure 3. Transition Function

The estimated values of the location (threshold) parameter  $c$ , the transition parameter gamma and the graph of the estimated transition function as a function of  $ter_{t-6}$ , provide useful information about the features of the transition itself and the interpretation of the

model. Figure 3 shows the transition function. It can be seen that there is a moderate change from one regime to another. This is also indicated by the relatively low value of the estimated transition parameter  $\gamma = 4.001$ . The estimated threshold value of  $c = 3.725$  points to the halfway point of the transition. This means that when  $ter_{t-6} = c$ , then  $F(s_t; \gamma, c) = 1/2$ . It indicates the half-way point between the low regime terrorist activity and high regime terrorist activity for Turkey. There are many observations lying on both sides of this parameter, clearly implying the existence of two distinct regimes. These regimes can be defined with respect to the values of the past values of  $ter_t$  relative to the estimated threshold value  $c = 3.725$ . That is, when  $ter_{t-6} < 3.725$   $F(s_t; \gamma, c) = 0$ , associated with declines in FDI, then there is low state of terrorist activity. When  $ter_{t-6} > 3.725$ ,  $F(s_t; \gamma, c) = 1$ , this is associated with more severe decrease in FDI; in other words, high state of terrorist activity. Moreover, different parameter estimates can be seen for different regimes. Therefore, the LSTR model implies asymmetric responses of terror to FDI.

Equation 5.2 and 5.3 provides the LSTR estimation of the monthly data with one lag. The values in the parentheses are t values. Based on the estimate results obtained, it is understood that a non-linear type investigation of the relationship would be better. The result of the LSTR estimate shows that, the regime which has low terror activity has a coefficient value of -3.310 and it is statistically significant at 5% level of significance. The high level of terrorism state's coefficient value is -5.977 with a 10% significance level. The results show that the lag of the terror index has a significant negative impact on FDI in both of the regimes. This result is consistent with the previous results from the linear model. Moreover, the nonlinear estimation reveals that the detrimental effects of terror on FDI are larger in magnitude during high-level terrorist activity periods than during low level terrorist activity periods. This result is quite intuitive, and implies that the fear-of-heavy financial loss during high-level terrorist activity regime and therefore causes more distortions compared to low-level terrorist activity regime.

## 6. DISCUSSION AND CONCLUSION

The results provide evidence of a non-linear relationship between terrorism and foreign direct investment. Clearly, these results have important policy implications. The outcome shows that the causation from terrorist activity towards FDI holds during low and high level terrorist activity periods. This implies that an increase in terrorist activity always means a decrease in FDI. On the other hand, policymakers should be more careful during high level terrorist activity periods, as terror shocks seem to have a larger impact on FDI. We have mentioned that if the expected costs combined with terrorist movement do not exceed the expected costs associated with making recognitions, then the government should hold its position. Therefore, below the threshold level  $ter_{t-6} < 3.725$ , policy makers have low incentive to stop terrorist activities because of the low cost. If the terrorist activities increase and pass the threshold level  $ter_{t-6} > 3.725$ , the government should negotiate or else allocate sufficient resources to nullify the threat. Therefore, the threshold level is a good indication for policy makers to interact with the events. Thus, the information provided by the nonlinear model can influence the policy makers decision notably. On the other hand, the threshold obtained from nonlinear regression model has also important signals for foreign investors. The foreign investor who is less informed can



use this threshold level as an indicator that the country is risky or not. Therefore, they organize their investment decision with respect to this indicator. If terrorist activities increase and pass the threshold level  $ter_{t-6} > 3.725$  , the foreign director investor should decrease or stop FDI to Turkey. From these arguments, we can conclude that it is important to estimate threshold levels of terrorist activities for all countries which face terrorist events. Hence, for further study by using nonlinear time series analysis or nonlinear panel data analysis, this group of countries should be investigated in order to find a useful indicator for policy makers and foreign direct investors.

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