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MODELLING AND FORECASTING OF TURKEY CURRENT ACCOUNT IMBALANCE WITH THRESHOLD AUTOREGRESSIVE MODELS

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ABSTRACT

The increase in number of countries with current account deficit in recent years, and the emergence of studies analyzing whether these deficits make the economies more vulnerable to external shocks draws attention to current account imbalances. In addition, the significant effect of current account balance on macroeconomic policies requires building econometric models for the mentioned series and making forecast. However, it is seen that the empirical studies on current account balance for Turkey are based on linearity hypothesis and linear models. Moreover in these studies, the possibility of this series can be created with the nonlinear process has been ignored. In this paper it is assumed that if the current account series is nonlinear, then it can be adequately described by a TAR family model. In the case of this series is not linear, the aim is to choose appropriate TAR model and to make out-of-sample forecasts. The findings of this study can be outlined as follows: over the period 1998:01 to 2008:09, the share of current account balance to GDP is nonlinear; the model which best captures the nonlinearity is LSTAR.

1. INTRODUCTION

It is observed that due to the recent crises, the discussions on economic policies among economic commentators, politicians and academicians focus on large current account imbalances that experienced in many countries. One of the common tools used in this subject, balance of payments (BOP) is a statistical report indicating the status of foreign economic and financial relationships of the countries within a specific time period. BOP consists of a total of four items including particularly current accounts, capital and financial accounts, net errors and omissions and reserve assets.

Among the main items, current account includes trade balance, balance of services, balance of income and current transfers.[1] Besides, the BOP methodology uses a double-entry accounting system, which is every transaction is recorded as both a credit and a debit. If the debits exceed credits, in other words if a country spends more than it earns, current account deficit occurs; if credits exceed debits, current account surplus occurs.

According to ranking made by the IMF in 2007, the number of countries with current account deficit doubled the ones with current account surplus; among 181 countries, while number of countries with current account surplus was around 60, number of countries with current account deficit was almost 120.[2] In addition to the high number of countries with current account deficit, particularly the current account imbalances in emerging countries and transition countries increases the importance of the studies investigating whether large deficits can be associated with the crises between the years of 1990 and 2000s, and thus whether the deficit can make the economies more vulnerable to external shocks**.**[3]

As for the causes of financial crises, in recent years, while one group argues that the main reasons are the high current accounts deficits, and this signals a future danger; another group argues that current account deficits are only one of the main determinants. For example, Berg and Patillo (1998), Esquivel and Larrin (1998), Corsetti, Pesenti and Roubini (2000) and Adedeji (2001) find evidence that the rise in current account deficit increases the risk of crises and the large deficits are one of the main determinants of the crises.[4] On one hand, Edwards (2001) reports that whenever the public sector is at balance, current account deficit will not cause any problem for economies. After this evaluation, Edwards (2001) states that the rise of current account deficit will increase the possibility of a crisis; however that depends on how crisis is defined as much as the sample period used in analysis. On the other hand, Frankel and Rose (1996) suggest that both current account deficit and budget deficit of the government does not play an important role in typical crises and that important deficits does not increase the risk of monetary crises. Similarly, Arias and Erlandsson (2004) analyse whether, in addition to numerous variables, current account variable is a leading indicator of crises in South-eastern Asia using switching models. But they don't find a strong and significant correlation between current accounts deficits and financial crises.

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[1] http://www.tcmb.gov.tr/yeni/iletisimgm/Bulten_Turkce13.pdf (March, 2009)

[2] International Monetary Fund, World Economic Outlook Database. (Data and Statistics, 2007-2014) http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/weoselco.aspx?g=2001&sg=All+countries

[3] In these contexts, the crises experienced by Turkey, Mexico, Thailand, Korea, Malaysia, Russia and Brazil in 1994-1999 and by Turkey and Argentina in 2000 and 2001 can be given as important examples.

[4] In his study for Nigeria, Adedeji (2001) find that current account deficits may cause crises with structural weaknesses and macroeconomic instability; in their studies for 30 countries, Esquivel and Larrain (1998) find that current account imbalances explain the presence of monetary crises. Berg and Pattillo (1998) attempt to forecast 1997 Asia crisis using various models and reports that current account deficit is a precursor of crises. Corsetti, Pesenti and Roubini (2000) analyse Asian countries and finds that crises index which is defined in relation to external imbalance measured with current account deficit and depreciation of exchange rate are significantly correlated.

In addition, it should be considered that current account deficit is inevitable, especially for developing countries. The main reason for this is that these countries have to import goods such as expensive machine and equipment for development and its permanence and that their exports consist of relatively low-price goods. As a result of this, current account deficit based on foreign trade deficit occurs. No matter what reason it is, the fact that number of the countries with current account deficit increases and more importantly, the deficits become permanent and that USA is the country with the largest deficit made current account deficit one of the common main subjects in recent years. In this context, Turkey, which is among the emerging countries, draws attention with its high current account deficit. It is seen in Table 1 that excluding 1998 and 2001, permanent current account deficits occurred since 1999 and that it rapidly increased since 2002.

Table 1: Turkey's current account balance and economic growth data for 1998-2008 periods[5]

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Economic growth	2.31	-3.37	6.77	-5.70	6.16	5.27	9.36	8.40	6.89	4.62	3.71
Current account balance(CAB)	2000	-925	-9920	3760	-626	-7515	-14431	-22088	-32051	-38219	-41866
CAB/GDP	0.007	-0.003	-0.037	0.019	-0.002	-0.024	-0.036	-0.045	-0.060	-0.058	-0.056

For Turkey, it is reported that the concentration of private investments relatively in sectors with high import input share such as automotive, machine equipment, electronics is effective in increased deficits and that the rise of energy import prices particularity in crude oil, also added to the enhancement of current account deficit.[6] In addition to all these, valuation of the exchange rates after some speculative capital or hot money flows, higher increase in import than export with the effect of exchange rate and rapid growth can be listed among the causes of this increase.

The list in Table 2 indicates that in 2008, Turkey ranked the sixth among the countries with the highest deficit.

[5] Data for the first two variables are taken from the delivery system of CBRT http://evds.tcmb.gov.tr/ and last line calculated by authors.

[6] Central Bank of the Republic of Turkey (CBRT) Annual Report 2007, p.32.

Table 2: Countries with high current account deficit and surplus (*)

	First 10 highest current account deficit countries	***Quantity***		***First 10 highest current account surplus countries***	***Quantity***
1	USA	-568.800	1	Chine	368.200
2	Spain	-152.500	2	Germany	268.100
3	United Kingdom	-72.540	3	Japan	187.800
4	Italy	-68.820	4	Saudi Arabia	151.000
5	France	-58.000	5	Russia	97.600
6	**Turkey**	**-51.680**	6	Norway	84.350
7	Australia	-43.840	7	Kuwait	65.210
8	India	-38.390	8	Venezuela	48.440
9	Greece	-36.260	9	Holland	47.000
10	Portugal	-16.750	10	Singapore	35.580

(*) 1.000.000 USD, 2008 values.[7]

Besides, the facts that current account deficit of Turkey become chronic makes this subject commonly appear in the agenda of economy. The views in this subject in Turkey can be categorized in two groups. The first group points out to the possibility of global financial turmoil which has caused a considerable shrinkage and emphasizes that due to this level of current account deficit, Turkey can face a serious problem. On the other hand, the second group adopts an optimistic point of view emphasizing that Turkish economy will survive with a large current account deficit for long years and that the reserves of the Central Bank of the Republic of Turkey are high (Akkaçar, 2006). In other words, the first group perceive the high rise of the ratio of current account deficit to national income as a signal of crisis, while the second group argue that current account deficit in Turkey is not a problem at all. The official view is similar to the views of the second group. Their claims can be summarized as follows: As long as the current account deficit is financed, there will be no danger; and besides it should be considered as normal on the way of Turkey's European Union (Yeldan, 2005). According to this view, as foreign capital inflow continues, this issue will not be a problem; furthermore the realized high growth will only be sustained with this deficit. However, 2008 current account balance figures point out that, as indicted by the first group, in case of a potential crisis, Turkey can face a serious problem due to current account deficit.

As mentioned above, the analysis whether current account deficit makes the economies of developing countries fragile for shocks requires building econometric models and making forecasts using appropriate models. The forecasts will guide for the preparation of economic programs and this increases the importance of these types of studies.

[7] https://www.cia.gov/library/publications/the-world-factbook/rankorder/2187rank.html

2. LITERATURE REVIEW

The increasing interest for current account deficit is also reflected in the studies on this subject and fairly increased the number of theoretical and applied studies. It is seen that these studies are made for G7 countries, USA, England, France and Italy which have high levels of current account deficit and fall into first ten in the list and Canada and Latin America which are not included in the list which are also G7 counties.

The studies of Howard (1989), Mann (2002) and Edwards (2005) for the USA; Horne (2001) for Australia, and Hudson and Stennett (2003) for Jamaica can be given as an example of the studies which include theoretical approaches. Besides, a number of previous empirical studies including Tuffle (1996), Ansari (2004) and Matsubayashi (2005) for the USA; Wu, Chen and Lee (2001) and Lee and Chinn (2006) for G7 countries; Nason and Rogers (2002) for Canada; Kano (2008) for Canada and England; Adedeji and Handa (2008) for Nigeria; Bannaga (2004) for Sudan; Apergis, Katrakilidis and Tabakis (2000) for Greece; Gruber and Kamin (2007) for nineteen different countries; Greenidge, Holder and More (2011) for Barbados. Such studies generally use vector autoregressive (VAR) and vector error correction (VEC) models, Granger causality, co-integration analysis and panel data models.

In econometrics literature, there are relatively a few studies using regime switching models for modelling current account balance. These studies include Middendorf and Schmidt (2004) and Engel and Rogers (2006) for the USA; Clarida, Goretti and Taylor (2005) for G7 countries; Chortareas, Kapetanios and Uctum (2004) for Latin America countries; Nickel and Vansteenkiste (2008) for two different industrial countries; Chen (2011) for OECD countries. After explaining the causes of high USA current account deficit, Engel and Rogers (2006) and Middendorf and Schmidt (2004) model current account balance using two-regime and three-regime Markov-switching models, respectively. In the latter study, regimes are distinguished as a regime of a strong increasing deficit, a just slightly increasing deficit and a regime of a deficit reduction. Besides, they find that movements of the deficit are asymmetric. Similarly, for current account deficit, Chortareas et al., (2004), Clarida et al., (2005) and Nickel and Vansteenkiste (2008) conclude that, respectively, SETAR for Latin American countries; GARCH and TAR for G7 countries and TAR for industrialized countries are appropriate models. Chen (2011) examined whether or not the current account deficits for the OECD countries can be characterized by a unit root process with regime switching models. Related to Turkey current account balance, in addition to theoretical studies (Tiryaki, 2002; Uygur, 2004; Özatay, 2006 and Akçay and Üçer, 2008) there are studies which analyse the relationship of current account balance with different variables. A number of studies that include Yücel and Ata (2003), Hashemzadeh and Wilson (2006) and Ümit and Yıldırım (2008) examine the relationship between budget deficit and current account balance; Erbaykal(2007) tests the effect of exchange rate and economic growth on current account deficit; Sekmen(2008) analyses the interaction of current account deficit with macroeconomic and demographic variables; Lebe, Kayhan, Adıgüzel and Yiğit (2009) aim to analyse the effects of economic growth and real effective exchange rate on current account deficit and Kayıkçı (2012) examines the long-run relationship between the export and import ratios.

It is seen that all of these studies are made using VAR, causality and co-integration analyses under the assumption of linearity. Besides, Eken (1990) attempts to model current account balance with using regression model also under the assumption of linearity.

The results of the literature survey reveal that the analysis of Turkey's current account balance are based on linear models and only a few studies attempt to modelling of the current account series. In this context, based on the assumption that nonlinear models will be more appropriate for Turkish current account balance, the purpose of this study is to determine the appropriate model in the case of regime switching and to make predictions using this model. The paper is organized as follows: The following section introduces TAR models which are among the regime switching models. The third section describes the data and gives the empirical results. The final section provides a summary of the study and its major conclusions.

3. METHODOLOGY

In the process that generates time series, due to crises or changes in government policies, breakages and even regime switches might occur. In such cases, the failure of the analysis of the series using linear models has led to the development of nonlinear models and nonlinear estimation methods. These models define the dynamic behaviour of the variables that switch due to different regimes. The differentiation of regime switching models according to the arising regime in time, has led to the classification of these models into two main classes. In the first one of these classes, it is agreed that as the regimes are created in the past, the regimes are determined based on the observable variable and that future can be exactly known using statistical techniques. On the other hand, the second class is based on the assumption that the regimes cannot be observed in reality, they can only be determined under the nonobservable stochastic process.

In Threshold Autoregressive (TAR) model, that fall into the first class and introduced by Tong (1978) and Tong and Lim (1980), the assumption is that the regime formed in t-period can be determined by the observable variable q_t and that the dynamic behaviour of the time series can be defined using the linear autoregressive (AR) model in each regime. Furthermore, in these models, transition between the regimes is determined by threshold value or values, and the threshold principle allows for the analysis of a complicated stochastic system by diving it into smaller sub-systems. Model type is determined by smooth or sharp transition and also by the fact that transition variable is the linear component of endogenous, exogenous or many variables. When q_t which is called as the threshold variable, takes a lagged value of the time series itself, the resulting model is s*elf-exciting TAR* (SETAR). In this model, q_t becomes y_{t-d} for delay parameter $d > 0$ and thus the assumption is that the boundary between the regimes is determined by a certain value of threshold y_{t-d}.

The observations of y_t are generated either from the first regime when y_{t-d} is equal or smaller than the threshold or from the second regime when y_{t-d} is greater than the threshold. In SETAR model, which is introduced by Tong (1978) and again developed by Tong (1983; 1990), there is a sharp transition between the regimes.

SETAR model generated under two regime assumptions for $d=1$ is written as follows; $SETAR(2; p_1, p_2)$

$$y_t = \begin{cases} \phi_{1,0} + \sum_{i=1}^{p_1} \phi_{1,i}\, y_{t-i} + \varepsilon_{1t} & \textit{for } y_{t-1} \le c \\ \phi_{2,0} + \sum_{i=1}^{p_2} \phi_{2,i}\, y_{t-i} + \varepsilon_{2t} & \textit{for } y_{t-1} > c \end{cases} \tag{1}$$

Where p_1 and p_2 are the lag orders in lower and upper regimes of AR model; c is the threshold value and y_{t-1} is threshold variable. Error term ε_{it} is assumed to be independently and identically distributed white noise process, conditionally depend on the past values of the times series. Considering $\Omega_{t-1} = [y_{t-1}, y_{t-2}, ..., y_{t-p}]$, the mean is $E[\varepsilon_{it} \mid \Omega_{t-1}] = 0$ and variance is $E[\varepsilon_{it}^2 \mid \Omega_{t-1}] = \sigma^2$; it is indicated as $\varepsilon_{it} \sim i.i.d(0, \sigma^2)$.

An alternative SETAR model can be written as

$$y_t = (\phi_{1,0} + \sum_{i=1}^{p_1} \phi_{1,i} y_{t-i})(1 - I[y_{t-1} > c]) + (\phi_{2,0} + \sum_{i=1}^{p_2} \phi_{2,i} y_{t-i}) I[y_{t-1} > c] + \varepsilon_t \tag{2}$$

where $I[A]$ is an indicator function which takes the value of $I[\mathrm{A}] = 1$ when event A is realized; and the value of $I[\mathrm{A}] = 0$, in case of other conditions. (Franses and van Dijk, 2003, p.71).

If the indicator function in SETAR model is replaced by a transition function $o < G(z_t) < 1$, the resulting model is called as a *smooth transition autoregressive* (STAR) model. Where z_t is a transition variable similar to the threshold value in TAR model. In STAR model, which was introduced by Chan and Tong (1986) and developed by Teräsvirta (1994), there is a smooth transition between the regimes. General specification of 2-regime STAR model is as follows:

$$y_t = (\phi_{1,0} + \sum_{i=1}^{p_1} \phi_{1,i} y_{t-i})(1 - G(z_t; \gamma, c)) + (\phi_{2,0} + \sum_{i=1}^{p_2} \phi_{2,i} y_{t-i}) G(z_t; \gamma, c) + \varepsilon_t \tag{3}$$

When $z_t = y_{t-1}$ for $d=1$, STAR model generated under two-regime assumption can be written as;

$$y_t = (\phi_{1,0} + \sum_{i=1}^{p_1} \phi_{1,i} y_{t-i})(1 - G(y_{t-1};\gamma,c)) + (\phi_{2,0} + \sum_{i=1}^{p_2} \phi_{2,i} y_{t-i}) G(y_{t-1};\gamma,c) + \varepsilon_t \quad (4)$$

(Franses and van Dijk, 2003, p. 77). Where p_1 and p_2 are the lag orders of AR models, y_{t-1} is transition variable, G is the continuous function which slowly switches from 0 to 1 as y_{t-1} increases which yields a non-linear asymmetric adjustment and $\varepsilon_t \sim n.i.d(0,\sigma^2)$. Parameter c shows the threshold value between the two regimes corresponding to $G(y_{t-1};\gamma,c)=0$ and $G(y_{t-1};\gamma,c)=1$ and parameter γ identifies the shape of transition from a regime to another, and it represents the speed of transition. (Teräsvirta, 1994, p.208).

There are two variants of STAR models due to the difference in transition functions; *logistic STAR* (LSTAR) and *exponential STAR* (ESTAR) (Teräsvirta, 1994). In equation 4, for $d=1$, when transition function is

$$G(y_{t-1};\gamma,c) = (1+\exp[-\gamma(y_{t-1}-c)])^{-1} \quad (5)$$

then the resulting model is LSTAR;

$$G(y_{t-1};\gamma,c) = (1+\exp[-\gamma(y_{t-1}-c)^2]) \quad (6)$$

then the resulting model is ESTAR. (Van Dijk, Teräsvirta and Franses, 2000, p.2-3.)

The regime based differences between these models are outlined as follows; the LSTAR model implies that regimes based on low and high current account ratio (i.e. different regimes) have different dynamics whereas the ESTAR model implies that the two regimes have similar dynamics but the transition period can have different dynamics. Besides, in LSTAR model, adjustment takes place in every period but the smoothness of adjustment varies with the extent of the deviation from equilibrium. In LSTAR model, the transition function is monotonically increasing in y_{t-1} and yields asymmetric adjustment toward equilibrium in the model.

In this context, Teräsvirta (1994) denotes difficulties with the estimation of c and γ. When γ is large, the slope of the transition function at c is steep, and a large number of observations in the neighbourhood of c would be needed to estimate γ accurately. Even relatively large changes in γ then have only a minor effect on the shape of *G*. As a result, the sequence of estimates for γ may converge rather slowly. To eliminate this and to find appropriate preliminary/initial value, transition function is divided into the standard deviation of the series, σ_y (Teräsvirta, 1994, p.208-209)

Building of SETAR and STAR models starts with determining p_i, which is the lag order of linear AR model using Akaike information criteria (*AIC)* and continues with determining delay parameter d . In SETAR model, d is selected after separate nonlinearity test for each delay and by non-rejection of nonlinearity hypothesis. Nonlinearity test is made using;

$$\hat{F}(p,d)=\frac{\left(\sum \tilde{e}_t^2 - \sum \hat{\varepsilon}_t^2\right)/\left(p+1\right)}{\sum \hat{\varepsilon}_t^2 /\left(n-d-b-p-h\right)}$$

statistics which is calculated based on recursive residuals and arranged autoregressions [8] for SETAR model. In the statistics which has a F distribution, $\tilde{e}_t^2$ refers to the sum of squared residuals obtained by recursive least squares method from the arranged autoregression; $\hat{\varepsilon}_t^2$ refers to the sum of squared residuals obtained by the least squares method from linear regression. The final stage in SETAR model is determining the threshold value/values and estimation of the model (Tsay, 1989, pp. 233, 236). On the other hand, in STAR model, linearity test is performed for different values of d to auxiliary regression;

$$\hat{v}_t = \beta_0 + \beta_1' w_t + \sum_{j=1}^{p} \beta_{2j} y_{t-j} y_{t-d} + \sum_{j=1}^{p} \beta_{3j} y_{t-j} y_{t-d}^2 + \sum_{j=1}^{p} \beta_{4j} y_{t-j} y_{t-d}^3 + u_t \qquad (8)$$

where $\hat{v}_t$ represents the residuals saved from the chosen AR model. Linearity test is applied for each d between the values of $1 \le d \le p$ and if null hypothesis is rejected for more than one d value, then most strongly reject linearity is considered as an appropriate delay for the transition variable.

Considering $w_t = \left(y_{t-1}, \ldots, y_{t-p}\right)'$, STAR model linearity test is made based on LM test under null hypothesis;

$$H_0' : \beta_{2j} = \beta_{3j} = \beta_{4j} = 0, \qquad j = 1, \ldots, p .$$

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[8] For n number of observations, $AR(p)$ model was specified as $y_t = (1, y_{t-1}, \ldots, y_{t-p})\beta + \varepsilon_t$ for $\mathrm{t} = \mathrm{p}+1, \ldots, \mathrm{n}$. In the model, β refers to $(p+1)$ dimensional coefficients vector, ε_t refers to error terms. Arranged autoregressions are the divided version of the above arranged autoregressions depending on various values. TAR model fulfils its aims if it is arranged according to threshold values.

Test statistic $LM_2 = (SSR_0 - SSR) / \hat{\sigma}^2$ has a distribution of χ^2 with degrees of freedom $(3p)$; SSR_0 refers to sum of squared residuals obtained from the restricted model under H_0' hypothesis, while SSR refers to sum of squared residuals obtained from unrestricted model under alternative hypothesis. For STAR model, after the linearity test and finding d , selection of functional form is made under the hypothesis formed by restricting the parameters auxiliary regression (8).

To determine the functional form of STAR model, three different nested hypotheses are generated and F testing is made. (Teräsvirta, 1994, p.211) For this purpose, the following null hypotheses are tested;

$$H_{01}: \beta_{4j} = 0, \quad j = 1, \ldots, p \qquad (F_4)$$

$$H_{02}: \beta_{3j} = 0 / \beta_{4j} = 0, \quad j = 1, \ldots, p \qquad (F_3)$$

(9)

$$H_{03}: \beta_{2j} = 0 / \beta_{3j} = \beta_{4j} = 0, \quad j = 1, \ldots, p \quad (F_2)$$

If the probability value (*p*-value) of F_3 (the test of H_{02}) is the smallest of the three, appropriate model is an ESTAR model, otherwise choose a LSTAR model. (Teräsvirta, 1994, p.212). After selecting the functional form, the final stage in STAR model is estimating the model using nonlinear least squares (NLLS) or maximum likelihood (ML) method.

4. DATA AND EMPIRICAL RESULTS

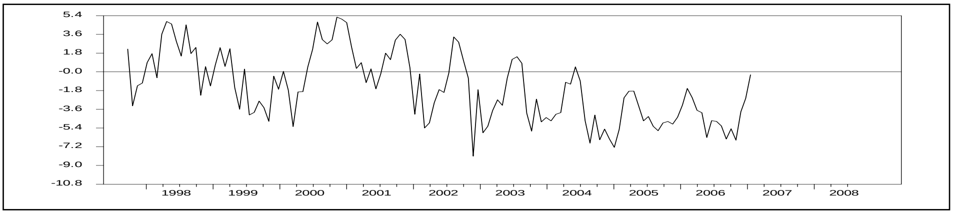
This section of the study attempts to find an answer to the question whether the current account balance over the period 1998:01 to 2008:09 has a regime switching; and in this context whether it can be modelled with regime switching models. The reason for choosing the year 1998 as the starting point is that this year is the start of a variation in general balance, current account, capital and financial accounts and starting from 1998, wave lengths differed and fluctuations increased. 1997 Asian and 1998 Russian crises can be shown as the main reason for this change. In the period following the start of these crises, serious constrictions emerged in world manufacturing and trade. In addition to the reflections of this in Turkey, increased risk caused the outflow of considerable speculative (hot) money, which in turn, increased fluctuations. Also we choose 2008 year-end as the finishing point to examine the forecast performance of the model to capture the global crisis.

Firstly, it is noted that, to compare the results of the studies and to make a significant comparison, instead of current account balance, the share of *current account balance (CAB)* in *GDP,* that is *current account ratio (CAR)* is analysed. Similarly, it is seen that this approach is used in various studies.

For example, in his comments on current account balance, Chairman of the Central Bank of the Republic of Turkey, Yılmaz, uses the ratio of the mentioned series to Gross National Product (GNP)[9]; on the other hand, Edwards (2001), Chortareas, Kapetanios and Uçtum (2004), Tanner and Samake (2006), Togan and Ersel (2007) and Akçay and Üçer (2008) use the ratio to Gross Domestic Product (GDP) in their studies. Furthermore, the data of the present study is analysed without deseasonalization. In some of the previous studies on current accounts are made use of various filters to deseasonalize the series and that the analysis are made on deseasonalized series (For example Lee and Chinn, 2006). However, the findings of the studies particularly of those conducted on business circles and unemployment revealed that deseasonalization can affect the nonlinear properties of time series, it can mask or even totally eliminate the nonlinear process in the time series, it will make the series nonlinear or change the nonlinearity type of the series (Ghysels, Granger and Siklos, 1996; Luginbuhl and de Vos, 2003; Mir and Osborn, 2004). Franses and Paap (1999) and Franses and de Bruin (2000) report that there are variations in the models specified for seasonally adjusted and non-adjusted series. Based on these findings, considering that deseasonalization will disturb the basic dynamics of the series and cause a difference in the regimes in the present study, it is decided that it will be appropriate to make an analysis without deseasonalization.[10]

As mentioned above, *CAR* series used in the study is obtained by dividing *CAB* to *GDP*, and *GDP* and *CAB* data are taken from the CBRT Electronic Data Delivery System.[11] The graph of the series is displayed in Fig. 1 and some statistics of the series are shown in Table 3.

Fig. 1: Time graph of current account ratio series



[9] Durmuş Yılmaz, CBRT 75th Regular General Assembly Opening Remarks, April 6th, 2007, Ankara.

[10] Various methods are used in deseasonalization. Since these methods might affect analysis results, selection of the followed approach is important. For example, if we use a filter like X-11, turning points of the regression would be degraded and this would in turn disturb the form of the regime. As a result of this, results which were different from the reality would be obtained. For further information, see Skalin and Teräsvirta (2000), Fattouh (2005) and Mir, Osborn and Lombardi (2005).

[11] http://evds.tcmb.gov.tr/

Table 3: Some descriptive statistics for current account ratio series

Statistics	*Value*	*Critical values for T=100*
Sample mean	-2.762	
Standard error	3.742	
Skewness (SK)	-0.236	0.576
Excess kurtosis(EK)	-0.900	LV= -0.80 / HV=1.52
Jarque-Bera (JB)	5.561	5.99
(A)DF (τ -statistics)	-4.680	τ_{τ} =-3.45
KSS Test	-4.342	t_{NL} =-3.40

As seen in Fig. 1, from the beginning 2004:11, current account ratio becomes negative and permanent; Table 3 indicates that the series varies between -10.28% and 5.05%, it is symmetric and platykurtic.[12] Table 3 also reports univariate ADF unit root test and nonlinear KSS unit root test on current account ratio for the full sample. The results for *CAR* series indicate that the null of nonstationarity is rejected at the 5% significance level.

As mentioned above, it is seen that in many studies on various countries and Turkey, after determining that the series are stationary, the models are specified with the assumption of linearity. However, prior to the modelling, the linearity should also be tested.

For this reason, in the first stage of TAR type model building, firstly the series will be specified with linear regression model to determine the lag length, secondly nonlinearity in the series will be tested and the delay parameter will be determined, thirdly in case that the series has nonlinear process, threshold value will be calculated using the method proposed by Tsay (1989).

According to the steps written above, firstly, to determine the lag length appropriate for TAR models, the series is specified with linear regression model and using AIC[13], p is found to be 14. Secondly, to test nonlinearity of the series, nonlinearity test is applied and the results of test are given in Table 4.

Table 4: Results of nonlinearity test

	d=1	*d=2*	*d=3*	*d=4*	*d=5*	*d=6*	*d=7*	*d=8*	*d=9*	*d=10*	*d=11*	*d=12*	*d=13*	*d=14*
F-stat	1.89	*0.85*	*1.21*	*1.93*	*1.05*	*0.63*	*0.56*	*0.53*	*0.98*	*0.99*	*0.83*	*1.04*	*0.60*	*1.19*
p-value	*0.03*	*0.61*	*0.27*	***0.03***	*0.41*	*0.83*	*0.89*	*0.91*	*0.47*	*0.47*	*0.63*	*0.41*	*0.86*	*0.28*

[12] Since skewness coefficient is $SK = |-0.236| < 0.576$, normality can not be rejected and it is decided that the series is symmetric. As the kurtosis coefficient is $EK = -0.900 \leq -0.80$, normality is rejected and it is decided that the series is platykurtic.

[13] Using the knowledge that Bayesian information criterion **(**BIC**)** gives better results when number of observations in below 200 (Strikholm and Teräsvirta, 2005, p.20), in this study lag lengths were calculated using both BIC and AIC, however, it was found that there was no difference between these two for study data and only AIC information was provided. For a similar operation see Arestis, Cipollini and Fettouh (2003), Fattouh (2005), Skalin and Teräsvirta (2000) and Strikholm and Teräsvirta (2005).

According to the p-value in Table 4, linearity is rejected only in delay 1 and 4. However, since linearity is more strongly rejected in delay 4, lag length so delay of the threshold variable is selected as $d = 4$.Then, to determine whether there is a threshold value causing regime switching in the series, threshold testing is performed. For this purpose, using bootstrap method, after 5000 repetitions, F-statistic is calculated as 5.678 and it is decided that there is a threshold value causing regime switching in the model.

Thirdly, threshold value is calculated as -0.033 using the method proposed by Tsay (1989, p.235). This indicates that there are two different regimes in CAR series and it will be appropriate to specify two different regression models which are above and below

-3.3%.

In the second stage, suitable TAR type model will be specified for the series. For this, firstly to find appropriate lag lengths, models with various delays (lags) are tried and in the first regime 1 and 3, in the second regime 2 and 13 are found to be statistically significant delays. Secondly, specified SETAR model is estimated by NLLS, and estimation results of this model are given in Table 5.

Table 5: Estimation results of the SETAR model

$$CDO_{t-4} \le -0.033$$

$$CDO_t = \underset{(0.005)}{-0.015} + \underset{(0.162)}{0.364}\, CDO_{t-1} + \underset{(0.170)}{0.487}\, CDO_{t-3}$$

$$CDO_{t-4} > -0.033$$

$$CDO_t = \underset{(0.004)}{-0.010} + \underset{(0.124)}{0.405}\, CDO_{t-2} + \underset{(0.101)}{0.321}\, CDO_{t-13}$$

$LM(12) = 13.367$ $ARCH(12) = 22.871$ $JB = 5.07$ $SSR = 0.398$

$AIC = 0.598$

It is shown in Table 5 that model parameters are statistically significant, they achieve the sufficiency condition for stationarity[14], and there is no autocorrelation and heteroscedasticity problem. Following this, in-sample forecast success of SETAR model is investigated. Forecast graph obtained at this stage is displayed in Fig. 2, and forecast evaluation criteria are given in Table 6.

[14] $(0,364 + 0,487) < 1$ and $(0,405 + 0,321) < 1$ are sufficiency conditions for the stationarity of two-regime AR models (Hansen, 1997, p.4. Assumption 1.2)

Fig. 2: In-sample forecast graph of the SETAR model

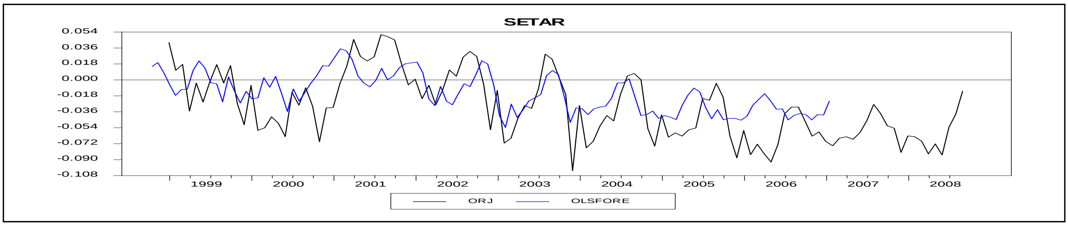


Table 6: Forecast evaluation criteria of the SETAR model

	From 1999:03 to 2008:09
Mean Error (ME)	0.0213
Mean Absolute Error (MAE)	0.0419
Root Mean Square Error (RMSE)	0.0671

Table 6 shows that the forecast evaluation criteria are close to zero, and in Figure 2, it is seen that the turning points is caught with small differences.

These reveal the success of in-sample forecast of the model. In the third stage, it will be investigated to see which STAR model, LSTAR or ESTAR, is appropriate for the *CAR* series. For this purpose, firstly linearity will be tested and delay parameters will be determined. The results of linearity test that is proposed by Terasvirta (1994), for lag length 14 which is determined by AIC, are given in Table 7.

Table 7: Results of nonlinearity test

	d=1	*d=2*	*d=3*	*d=4*	*d=5*	*d=6*	*D=7*	*d=8*	*d=9*	*D=10*	*d=11*	*d=12*	*d=13*	*d=14*
F-stat.	2.00	*0.93*	*1.74*	*1.83*	*0.87*	*1.03*	*1.45*	*1.16*	*1.51*	*0.99*	*1.26*	*0.75*	*0.78*	*1.27*
p-value	***0.00***	*0.59*	*0.02*	*0.015*	*0.672*	*0.44*	*0.09*	*0.29*	*0.07*	*0.49*	*0.20*	*0.83*	*0.79*	*0.19*

The values in Table 7 show that linearity is rejected in delays $1,3,4,7$ and 9 and that the series shows a nonlinear structure. However, since the *p*-value indicates that linearity is more strongly rejected in delay 1, $d=1$ is selected. Secondly, under three different hypothesis proposed by Teräsvirta (1994), F statistics are calculated and the results are given in Table 8.

Table 8: Results of test for functional form

***d* =1**	***F Test***	***p-values***
F_4	1.824	0.056
F_3	1.082	0.387
F_2	2.488	0.005

It is clearly seen in Table 8 that F_2 has the lowest *p*-value. This result indicates that for *CAR* series, LSTAR is the appropriate model. Thirdly, after the selection of appropriate functional form, the model is estimated by ML method and the results are given in Table 9.

Table 9: Estimation results of the LSTAR model

$$CDO_t = \underset{(0.078)}{0.506} CDO_{t-2} + \underset{(0.115)}{0.549} CDO_{t-12} + (\underset{(0.319)}{0.657} CDO_{t-3} - \underset{(0.340)}{1.108} CDO_{t-4} - \underset{(0.348)}{0.135} CDO_{t-12} - \underset{(0.193)}{1.032} CDO_{t-14}) \times$$

$$(1 + \exp[-\underset{(0.084)}{0.220}(CDO_{t-1} + \underset{(0.000)}{0.037})])^{-1}$$

$$LM(12) = 18.337 \quad ARCH(12) = 21.314 \quad JB = 5.87 \quad SSR = 0.278 \quad AIC = 0.425$$

The results in Table 9 show that the LSTAR model parameters are statistically significant, there is no autocorrelation and heteroskedasticity problem in the residuals, and that they are normally distributed. In the same table, it is seen that the values of parameters c and γ are -0.037 and 0.220, respectively.

The fact that the calculated γ value is not high indicates the smoothness in transition from one regime to another, and its statistical significance reveals that LSTAR is the appropriate model for the series. Then, in-sample forecast success of LSTAR model is investigated. Realized values and generated forecast values are shown together in Fig. 3, and forecast evaluation criteria are given in Table 10.

Fig. 3: In-sample forecast graph of the LSTAR model

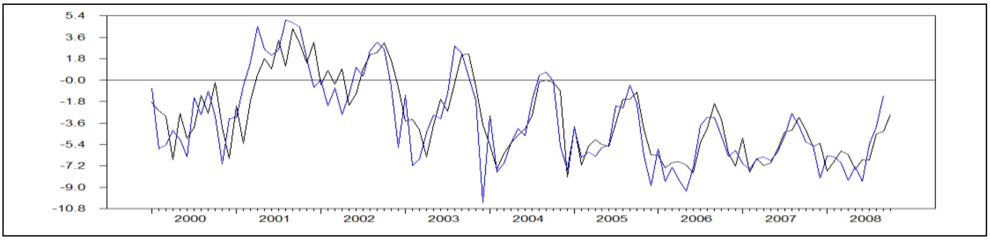


Table 10: Forecast evaluation criteria of the LSTAR model

	from 1999:06 to 2008:09
Mean Error (ME)	0.0092
Mean Absolute Error (MAE)	0.0278
Root Mean Square Error (RMSE)	0.0402

Forecast evaluation criteria in Table 10 indicate that LSTAR model is also successful in modelling *CAR.* Furthermore, Fig. 3 shows that the success of the in-sample forecast of this model in capturing all turning points of the series is more successful than SETAR model (Fig. 2). To decide which model is better, AIC, SSR, ME and RMSE values are given in Table 11 collectively. Eventually, Table 11 shows that the best model that captures all nonlinearity is LSTAR model.

Table 11: In-sample forecast evaluation criteria of the SETAR and LSTAR models

	AIC	**SSR**	**ME**	**RMSE**
SETAR	0,598	0,398	0.021	0.067
LSTAR	0,425	0,278	0.009	0.040

Another aim of the study is to make out-of-sample forecast for the series after choosing the appropriate model. However, the findings of many previous studies reveal that in-sample forecast success of nonlinear models are high, but their out-of-sample forecasts do not have much advantage than linear models (Diebold and Nason, 1990; De Gooijer and Kumar, 1992; Terasvirta and Anderson, 1992; Tiao and Tsay, 1994; Dacco and Satchell,1999; Sarantis, 1999; Stock and Watson, 1999 and Teräsvirta, van Dijk and Medeiros, 2005). Among these studies, De Gooijer and Kumar (1992) state that better forecasts can be obtained in the case of the short forecast horizon (De Gooijer and Kumar, 1992, p.151, 154). Besides Tiao and Tsay (1994, p.115-116) compare forecast success of two-regime SETAR and AR(2) models (within the context of MSFE criteria) suggest that for the extension period, SETAR model is not more advantageous than the AR model, however, at recession/contradiction period, SETAR's from 2 to 4-step-ahead forecast was more successful.

Unlike these findings, Boero and Marrocu (2002) specify AR, RW, GARCH, STAR and SETAR models for the return of three exchange rates against US Dollar and compare the in-sample and out-of-sample forecast success of these models with different criteria and alternative procedures, and reports that nonlinear models are superior to linear models. Feng and Liu (2003, p.14) also conclude that ARIMA and SETAR models are successful in in-sampling and out-sample forecast of GDP data for Canada, and besides this, the authors conclude that SETAR model yields a better result in the out-sample forecast.

In conclusion, it can be state that there is a common view suggesting that nonlinear models are more successful than linear models in capturing the properties of time series in sampling period, but the models can not show the same success for out-of sampling period.

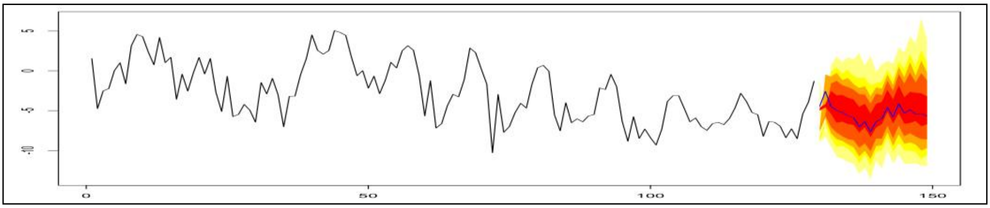
The main reason for this can be outlined that nonlinearity is found to be quite significant within the analysis period; however it fails to convey this outside the analysis period. In this subject, Diebold and Nason (1990) also report that one of the reasons for weak forecast of nonlinear models lied in the differences between in-sample and out-of-sample characteristics.

When we investigate the forecast approaches applied in the majority of the studies, it is seen that while choosing the forecast method and creating the forecast confidence interval, the fact that forecast density of nonlinear models is multimodal, residuals are asymmetric and these are not taken into consideration in these studies.

Therefore, in the present study, out-of-sample forecast of *CAR* series which is found to be nonlinear is performed by using the Highest-Density Forecast Region (HDR) approach of Hyndman (1995). For the related variable, HDR refers to the region when the density function exceeds the nominal threshold and HDR estimation typically involves determining the regions with high estimated density.[15]

This method, which is agreed to be appropriate for nonlinear series and asymmetric residuals, (van Dijk, Franses and Boswijk, 2000; Blasco, 2001; Niglio and Amendola, 2001 and Arango and Melo, 2006) is used in 20-step-ahead forecast of *CAR* series. Generated forecast graph is given in Fig. 4 and forecast evaluation criteria are displayed in Table 12.

Fig. 4: 20-step-ahead forecast graphics of the LSTAR model



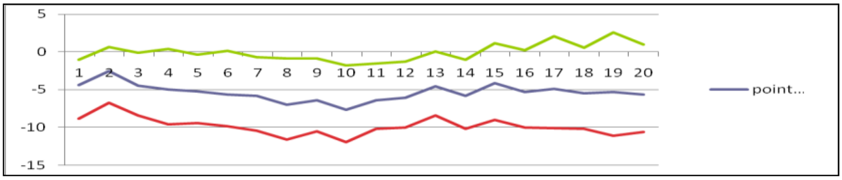
[15] The fact that in linear models, forecast confidence intervals are taken symmetrically around point estimations as forecast density is symmetrical and unimodal, is based on the assumption that conditional distribution of linear time series are normal. However, nonlinear series or non-normal (asymmetrical) residuals make the forecast density asymmetrical or multimodal. In this case, it was thought that symmetrical interval around the mean should not be the appropriate forecast, that the forecast intervals should be formed in such a way to be non-symmetrical.

Table 12: 20-step-ahead forecast evaluation criteria of the LSTAR model

	from 2008:10 to 2010:05
Mean Error (ME)	0.0867
Mean Absolute Error (MAE)	0.0963
Root Mean Square Error (RMSE)	0.1032

Small values of forecast evaluation criteria which are shown in Table 12 indicate the success of 20-step-ahead forecast made for *CAR* series. Besides, Fig. 5 shows point forecast values for the period from 2008.10 to 2010.05 and upper and lower confidence limits with 95% probability.

Fig 5: 20-step-ahead forecast points and upper and lower confidence limits



It is seen in Fig. 5 that the *share of current account deficit* which decreases between 2008:10-2008:12 periods in *GDP* increases particularly until 2009:05 and continues at the level of 6% until 2009:09 and then stabilises around 5% in the period until 2010:05.

This suggests that current account deficit ratio will continue around at the level of 5% with slight changes for 20 periods. Forecast findings support the view that global crisis which started in the USA in the final period of 2007 and began to affect world countries as of 2008, started at the end of 2008 in Turkey and caused a gradual increase in *current account GDP ratio* as of 2009. In addition, the results reveal that forecast values will constantly continue over the -3.7% threshold value calculated for CAR.

In this context, Dornbusch (2001, p.3) reports that if *CAD/GDP* ratio is exceeds 4%, it will pass to red zone in terms of crises. Dornbusch also reports that if the exchange rate rapidly gains value (25% and above in a 2 or 3 year period) and if the current account deficit exceeds 4%, without the prospect of a correction, that country will pass to the red zone. On the other hand, Milesi-Ferretti and Razin (1996, p.20) report that the fact that for 3-4 years, a permanent *current account deficit* exceeds a certain threshold like 5% of the *GDP* will not be an indicator that provides adequate information with sustainability.

Based on these findings and Dornbusch’s conclusions, considering that the fragility in the economy is increased, it can be stated that crisis will be inevitable even in a mild wind.

In conclusion, the finding of the present study suggesting that the *share of current account balance in GDP* has two different regimes which are above and below -3.7%, indicates that at the ratios over this value, it is difficult to sustain current account deficit. This finding is consistent with the finding of Çakmak and Varlık (2007) where the authors analyse the sustainability of current account deficit for Turkey and using Aristovnik’s (2006) formulation, they find the value of 3.6% for a moderate scenario.

5. SUMMARY AND CONCLUSIONS

The chronic current account deficit of Turkey since November 2002 excluding a few months and that Turkey ranked sixth in the list of countries with current account deficit in the year 2008 is the main motive behind the present study. Furthermore, the fact that the previous studies for this issue concentrated on linear models; besides insufficient in number modelling and out-of-forecasting efforts is the other motive of this study.

For this context, the first purpose of this paper is to investigate whether nonlinearities are present in the behaviour of Turkey current account balance and to find the appropriate TAR family model. In this manner, it can be argued that if nonlinearities are present in *CAB/GDP* behaviour then linear models are inappropriate. The second purpose is to generate out-of-sample forecasts with this model.

The main findings of the analysis of current account imbalances which involves the period 1998:01 to 2008:09 can be summarized as follows: firstly, the *ratio of current account balance to GDP* is nonlinear, and SETAR and LSTAR models are found to be successful in defining the nonlinear structure of the mentioned series. As a result of the comparison of the in-sample forecast success of these models, it is decided that LSTAR is the appropriate model and regimes based on low and high current account ratio have different dynamics. According to the empirical results, the series has one threshold and two regimes; the threshold value dividing the series into two regimes is -0.037, and that there are two different regimes below and above this value. Secondly, LSTAR model is used for forecasting purposes due to its in-sample forecast success. Using this model, 20-step-ahed forecast is performed using highest-density forecast region approach. In this context, the finding of the study is that current account deficit will rise towards the middle of 2009, however a less deficit will occur towards the end of the year and at the beginning of 2010, the *share of current account balance in GDP* will continue at the level of -5% and -6%.

When we compare this result with realized values it is seen that LSTAR model is succeed in out-of-sample forecast. Thirdly, the fact that all forecast values are significantly higher than the threshold value suggests that in case of an outbreak of a small crisis, it will be difficult to sustain the current account deficit. Besides, the results of the preset study reveals that nonlinear models are appropriate in modelling current account balance and that using linear model will be inadequate and lead to erroneous results.

In addition, the fact that the use of forecast approaches that are appropriate for nonlinear models increased out-of-sample forecast success and this points to the importance of the suitability of the forecast method to be selected with the nonlinear models. The fact that the forecasts will guide policy makers in economic programs adds to the importance of the present study.

The next step of the study is planned to extend the study by performing impulse-response analyses for the LSTAR model, to determine other variables affecting current account balance and their potential impacts.

REFERENCES

- Adedeji, O. (2001) The size and sustainability of the Nigerian current account deficit, International Monetary Fund Working Paper, No. 01/87.
- Adedeji,O. and Handa, J. (2008) The size and sustainability of the Nigerian current account deficits, The Journal of Developing Areas, 41, 1-25.
- Akçay, C. and Özler, Ş. (1998) Current account position of the Turkish economy: is there any cause for concern?, Boğaziçi Journal Review of Social, Economic and Administrative Studies, 12(1), 39-53.
- Akçay, C. and Üçer, M. (2008) A narrative on the Turkish current account, The Journal of International Trade and Diplomacy, 2(2), 211-238.
- Akkaçar, N. (2006) Cari işlemler açığını nasıl finanse edeceğiz? Net hata noksan tartışmalarına bir katkı. [How does current account deficit will be financed? A contribution to discussion of net error and omissions.] available at http://www.asam.org.tr
- Ansari, M. I. (2004) Sustainability of the US current account deficit: an econometric analysis of the impact of capital inflow on domestic economy, Journal of Applied Economics, 7(2), 249-269.
- Arango, L. E. and Melo, L. F. (2006) Expansions and contractions in Brazil, Colombia and Mexico: a view through nonlinear, Journal of Development Economics, 80(2), 501-517.
- Apergis, N., Katrakilidis, K. P. and Tabakis, N. M. (2000) Current account deficit sustainability: the case of Greece, Applied Economics Letters, 7, 599-603.
- Arestis, P., Cipollini, A., and Fattouh, B. (2003) Threshold effects in the US budget deficit, Centre for International Studies on Economic Growth Research Paper Series, 6, 18.

- Arias, G. and Erlandsson, U. G. (2004) Regime switching as an alternative early warning system of currency crises : an application to South-East Asia, Scandinavian Working Papers in Economics, No. 11.

- Aristovnik, A. (2006) How sustainable are current account deficits in selected transition economies? Available at http://mpra.ub.uni-muenchen.de/485/1/MPRA_paper_485.pdf

- Blasco, N. and Santamaria, R. (2001) Highest-density forecast regions: an essay in the Spanish stock market, Journal of Asset Management, 2(3), 274-283.

- Bannaga, A. A. (2004) Adjustment policies and the current account balance: empirical evidence from Sudan, University of Manchester, Development Economics and Public Policy Working Papers , No. 8.

- Berg A. and Pattillo, C. (1999) What caused the Asian crises: an early warning system approach, Economic Notes, 28, 285-334.

- Boero, G. and Marrocu, E. (2002) The performance of non-linear exchange rate models: a forecasting Comparison, Journal of Forecasting, 21, 513-542.

- Çakmak, U. and Varlık, C. (2007) Türkiye ekonomisinde cari işlemler açığının sürdürülebilirliği: Meksika örneği bağlamında bir değerlendirme [Sustainability of the current account deficits in the Turkish economy: an assessment in the context of the Mexican example], İktisat İşletme ve Finans, 22(259), 114-135.

- Chan, K. S. and Tong, H. (1986) On estimating thresholds in autoregressive models, Journal of Time Series Analysis, 7(3), 179-190.

- Chen, S.W. (2011) Current account deficits and sustainability: Evidence from the OECD countries, Economic Modelling, 28(4), 1455-1464.

- Chortareas, G. E., Kapetanios, G. and Uctum, M. (2004) An investigation of current account solvency in Latin America using nonlinear nonstationarity tests, Studies in Nonlinear Dynamics and Econometrics, 8(1), 1-17.

- Clarida, R. H., Goretti, M. and Taylor, M. P. (2006) Are there thresholds of current account adjustment in the G7?, National Bureau of Economic Research Working Paper, No. 12193
- Corsetti, G., Pesenti, P. and Roubini, N. (1999) The Asian crisis: an overview of the empirical evidence and policy debate, The Asian Financial Crisis: Causes, Contagion, and Consequences, UK, Cambridge, 127-162

- Dacco, R. and Satchell, S. (1999) Why do regime-switching models forecast so badly?, Journal of Forecasting, 18, 1-16.

- Dickey, D. A. and Fuller, W.A. (1979) Distribution of the estimators for autoregressive time series with a unit root, Journal of the American Statistical Association, 74, 427–431.
- De Gooijer, J. G. and Kumar, K. (1992) Some recent developments in non-linear time series modelling, testing and forecasting, International Journal of Forecasting, 8, 135–156.
- Diebold, F. and Nason, J. (1990) Nonparametric exchange rate predictions?, Journal of International Economics, 28, 315-328.
- Dornbusch, R. (2001) A primer on emerging market crises, National Bureau of Economic Research Working Paper, No. 8326.
- Edwards, S. (2001) Does the current account matter?, National Bureau of Economic Research Working Paper, No. 8275.
- Edwards, S. (2005) Is the U.S. current account deficit sustainable? If not, how costly is adjustment likely to be?, Brookings Papers on Economic Activity, 211-271.
- Eken, A. (1990) Cari işlemler dengesi üzerine model çalışması [A modelling study for current account balance], TCMB Araştırmalar, Tartışma Tebliği, No. 9020.
- Engel, C. and Rogers, J. H. (2006) The U.S. current account deficit and the expected share of world output, Journal of Economics, 53(5), 1063-1093.
- Erbaykal, E. (2007) Türkiye'de ekonomik büyüme ve döviz kuru cari açık üzerinde etkili midir? Bir nedensellik analizi [Do economic growth and foreign exchange rates have effects on the current deficit in Turkey? A causality analysis], ZKÜ Sosyal Bilimler Dergisi, 3(6), 81–88.
- Esquivel, G. and Larrain, F. (1998) Explaining currency crises, Harvard Institute for International Development Discussion Paper, No. 666, 1-36.
- Fattouh, B. (2005) Capital mobility and sustainability evidence from U.S. current account data, Empirical Economics, 30, 245-253.
- Feng, H. and Liu, J. (2003) A SETAR model for Canadian GDP: non-linearities and forecast comparisons, Applied Economics, 35(18), 1957-1964.
- Frankel, J. and Rose, A. (1996) Currency crashes in emerging markets: an empirical treatment, Discussion Paper, Board of Governors of the Federal Reserve System International Finance Discussion Papers , No. 534.
- Franses, P. H. and Bruin, P. (2000) Seasonal adjustment and the business cycle in unemployment, Studies in Nonlinear Dynamics and Econometrics, 4(2), 73-84.
- Franses, P. H. And Paap, R. (1999) Does seasonality influence the dating of business cycle turning points?, Journal of Macroeconomics, 21(1), 79-92.

- Franses, P. H. and van Dijk, D. (2003) Non-linear time series models in empirical finance, Cambridge University Press, Cambridge.
- Ghysels, E., Granger, C.W. J. and Siklos, P. (1996) Is seasonal adjustment a linear or nonlinear data filtering process?, Journal of Business and Economic Statistics, 14(3), 374-386.
- Gruber, J. W. and Kamin, S. B. (2007) Explaining the global pattern of current account imbalances, Journal of International Money and Finance, 26, 500-522.
- Hansen, B.E. (1997) Inference in TAR models, Studies in Nonlinear Dynamics and Econometrics, 2(1),1-14.
- Hashemzadeh, N. and Wilson, L. (2006) The dynamics of current account and budget deficits in selected countries if the Middle East and North Africa, International Research Journal of Finance and Economics, 5, 112-129.
- Horne, J. (2001) The current account debate in Australia: changing policy perspectives, Macquarie University, Department of Economics Research Papers, No. 0111.
- Howard, D. H. (1989) Implication of the U.S. current account deficit, The Journal of Economic Perspectives, 3(4), 153-165.
- Hudson, S. and Stennett, R. (2003) Current account sustainability in Jamaica, Bank of Jamaica, Working Paper, No: 02111.
- Hyndman, R. J. (1995) Highest-density forecast regions for nonlinear and non-normal time series models, Journal of Forecasting, 14, 431-441.
- Jarque, C. and Bera, A. (1980) Efficient tests for normality, homoscedasticity, and serial independence of regression residuals, Economics Letters, 6, 255–259.
- Kano, T. (2008) A structural VAR approach to the intertemporal model of the current account, Journal of International Money and Finance, 27(5), 757-779.
- Kayıkçı, F. (2012) Solvency of current account deficit in Turkey, Actual Problems of Economics, 128(2), 387-395.
- Lee, J. and Chinn, M. D. (2006) Current account and real exchange rate dynamics in the G7 countries, Journal of International Money and Finance, 25, 257-274.
- (2009) The empirical analysis of the effects of economic growth and exchange rate on current account deficit: Romania and Turkey samples, Journal of Applied Quantitative Methods, 4(1), 69-81.
- Luginbuhl, R. and De Vos, A. (2003) Seasonality and Markov switching in an unobserved component time series model, Empirical Economics, 28, 365-386.

- Mann, C. L. (2002) Perspectives on the U.S. current account deficit and sustainability, Journal of Economic Perspectives, 16(3), 131-152.

- Matsubayashi, Y. (2005) Are US current account deficits unsustainable? Testing for the private and government intertemporal budget constraints, Japan and the World Economy, 17, 223-237.

- Middendorf, T. and Schmidt, T. (2004) Characterizing movements of the U.S. current account deficit, Discussion Paper, Rheinisch-Westfälisches Institut für Wirtschaftsforschung, No. 0024.

- Milesi-Ferretti, G. M. and Razin, A. (1996) Sustainability of persistent current account deficits, National Bureau of Economic Research Working Paper, No. 5467.

- Mir, A. M. and Osborn, D. R. (2004) Seasonal adjustment and the detection of business cycle phases, European Central Bank, Working Paper, No. 357.

- Mir, A. M., and Osborn, D. R. (2004) Does seasonality change over the business cycle? An investigation using monthly industrial product series, European Economic Review, 48, 1309-1332.

- Mir, A. M., Osborn, D. R. and Lombardi, M. J. (2005) The effects of seasonal adjustment on the properties of business cycle regimes, Universita' degli Studi di Firenze, Dipartimento di Statistica, Econometrics Working Papers, No: 15.

- Nason, J. M. and Rogers, J. H. (2002) Investment and the current account in the short run and the long run, Journal of Money, Credit and Banking, 34(4), 967-86.

- Nickel, C. and Vansteenkiste, I. (2008) Fiscal policies, the current account and Ricardian equivalence, European Central Bank, Working Paper, No. 935.

- Niglio, M. and Amenda, A. (2001) Forecasting density of regime switching conditional heteroskedastic models. Available at http://www.dipstat.unina.it/Quaderni%20di%20statistica/volume%203/amenddef.PDF
- Özatay, F. (2006) Cari işlemler dengesine ilişkin iki yapısal sorun ve mikro reform gerçeği [Two structural problem related to current account balance and the fact that micro reform reality of micro reform], Uluslararası Ekonomi ve Dış Ticaret Politikaları, 1(1), 38-50.
- Sarantis, N. (1999) Modeling non-linearities in real effective exchange rates, Journal of International Money and Finance , 18, 27-45.

- Sekmen, F. (2008) Is current account deficit a message for economic crises for Turkey?, International Journal of Applied Econometrics and Quantitative Studies, 5(1), 49-60.

- Skalin, J. and Teräsvirta, T. (2000) Modelling asymmetries and moving equilibria in unemployment rates, University of Bielefeld Centre for Empirical Macroeconomics, Working Paper, No. 3.
- Stock, J. H. and Watson, M.W. (1999) A comparison of linear and nonlinear univariate models for forecasting macroeconomic time series, in R.F. Engle and H. White (eds.), Cointegration, Causality, and Forecasting: A Festschrift in Honor of Clive W.J. Granger, Oxford: Oxford University Press, 1-44.
- Strikholm, B. and Teräsvirta, T. (2005) Determining the number of regimes in a threshold autoregressive model using smooth transition autoregressions, Stockholm School of Economics, Working Paper, No. 578.
- Tanner, E. and Samake, I. (2006) Probabilistic sustanability of public dept: a vector autoregression approach for Brazil, Mexico, and Turkey, IMF, Working Paper, No. 06/295.
- TCMB Yıllık Rapor [Annual Report] 2007, Ankara, 2008, Available at http://www.tcmb.gov.tr/research/yillik/07turkce/07turkce.pdf
- Teräsvirta, T. (1994) Specification, estimation, and evaluation of smooth transition autoregressive models, Journal of the American Statistical Association, 89, 208-218.
- Terasvirta, T. and Anderson, H. M. (1992) Characterizing nonlinearities in business cycles using smooth transition autoregressive models, Journal of Applied Econometrics, 7, 119-136.
- Terasvirta, T., van Dijk, D. and Medeiros, M. C. (2005) Linear models, smooth transition autoregressions, and neural networks for forecasting macroeconomic time series: A re-examination, International Journal of Forecasting, 21(4), 755-774.
- Tiao, G. C., and Tsay, R. S. (1994) Some advances in non-linear and adaptive modelling in time-series, Journal of Forecasting, 13, 109–131.
- Tiryaki, S. T. (2002) Cari işlemler hesabına çeşitli yaklaşımlar, sürdürülebilirlik ve Türkiye örneği [Various approaches to current account balance, sustainability and Turkey case], TCMB Araştırma, Çalışma Tebliğ, No. 8.
- Togan, S. and Ersel, H. (2007) Current account sustainability: the case of Turkey. Macroeconomic Policies for EU Accession, 268-293. Ed. E.Başçı, S.Togan ve J. Von Hagen, Edward Elgar Pub. İnc., USA.
- Tong, H. (1978) On a threshold model, Pattern Recognition and Signal Processing (C. H. Chen, ed.), 575-586.

- Tong, H. and Lim, K.S. (1980) Threshold autoregression, limit cycles and cyclical data, Journal of Royal Statistical Society Series B, 42(3), 245-292.
- Tong, H. (1983) Threshold models in non-linear time series analysis, Lecture Notes in Statistics, No.21. Springer-Verlag, New York, USA.
- Tong, H. (1990) Nonlinear time series: a dynamical system approach, Clarendon Press, Oxford.
- Tsay, R. S. (1989) Nonlinearity tests for time series, Biometrika, 73(2), 461-466.
- Tsay, R. S. (1989) Testing and modeling threshold autoregressive processes, Journal of the American Statistical Association, 84, 231-240.
- Tuffle, D. (1996) Why is the US current account deficit so large?, Southern Economic Journal, 63(2), 515-525.
- Uygur, E. (2004) Cari açık tartışmaları [The current account debate in Turkey], İktisat, İşletme ve Finans, 19(222), 5-20.
- Ümit, A. Ö. and Yıldırım, K. (2008) İkiz açık hipotezi: Türkiye analizi [Twin deficits hypothesis: An analysis for Turkey], İktisat, İşletme ve Finans, 23(267), 116-132.
- Van Dijk, D., Franses, P. H., and Boswijk, H. P. (2000) Asymmetric and common absorption of shocks in nonlinear autoregressive models, Econometric Institute Research Report, EI2000-01 / A
- Van Dijk, D., Terasvirta, T. and Franses, P. H. (2000) Smooth transition autoregressive models - a survey of recent developments. Econometric Institute Report EI 2000-23/A Revision Dat, Erasmus University, Rotterdam.
- Wu, J. L., Chen, S. L. and Lee, H.Y. (2001) Are current account deficits sustainable? Evidence from panel cointegration, Economics Letters, 72, 219-224.
- Yeldan, E. (2005) Türkiye Ekonomisi’nde Dış Açık Sorunu ve Yapısal Nedenleri [The Problem of Current Account Deficit in Turkish Economy and structural reasons], Çalışma ve Toplum, Available at http://www.calismatoplum.org/sayi7/makale2.pdf
- Yücel, F. and Ata, A.Y. (2003) Eş-bütünleşme ve nedensellik testleri altında ikiz açıklar hipotezi:Türkiye uygulaması [Twin deficits hypothesis under cointegration and causality tests: An application of Turkey], Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Dergisi, 12, 12.