Capital Flows and Current Account Dynamics in Turkey: A Nonlinear Time Series Analysis

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Abstract

The paper offers an analysis of current account dynamics and its sustainability in Turkey using quarterly data. The focus is on the nonlinear characterization of the long – run intertemporal budget constraint and the stationarity tests. Several well-known tests are applied to identify nonlinearity in the current account time series. The analysis reveals that while the classical unit root tests based on linear specification give rise to conflicting results as to the nonstationarity of the current account deficit series, a threshold unit root test due to Caner and Hansen (2001) fails to reject the null of nonstationarity, implying that the intertemporal budget constraint would not be satisfied in the long run.

JEL Classification: C22, F32

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1. Introduction

Its remarkable growth performance notwithstanding, the Turkish economy has displayed increasing current account deficits for the last decade. In an attempt to gauge the risk of overheating in a number of economies, The Economist has ranked Turkey as the 6th economy after Argentina, Brazil, Hong Kong, India and Indonesia, on the basis of an emerging – market overheating index – see, Economics focus, The Economist, July 2nd 2011. While the onset of the Great Recession in 2008 reduced the deficit considerably over the next three quarters, the current account deficit appeared to have resumed its momentum within a year. By the end of 2011, Turkey's current account deficit reached a record high of 10.3 percent of its GDP. Publicly recognizing the risks associated with such high external deficits, Turkish government authorities have recently introduced several expenditure switching policies. The Central Bank, on the other hand, let the Turkish Lira depreciate by almost 20 percent within a short period of three months in 2011.

This study is aimed at shedding light on the long run dynamics of the current accounts in the Turkish economy. More specifically, we propose to analyze the long run sustainability of the current account deficits. The policy implications of this empirical investigation are obvious. For nearly three decades, increasing current account deficits have often resulted in deep financial crises in Turkey: the 1994 and 2001 financial crises have all been preceded by increasing current account deficits, and the last five years have witnessed record deficits, exacerbated by rising demand for imported energy. Thus the crucial question is: are these current account deficits sustainable in the long run?

Indeed, overvalued exchange rates, skyrocketing oil prices, and high domestic real interest rates on the one hand, and the rapid inflow of hot money on the other, have all contributed to this steep rise in current account deficit. In a period of just one year, before the onset of the international financial meltdown in November 2008, net foreign capital inflow into the Turkish economy increased from US$ 48.1 billion to US$ 52 billion. Consequently the current account deficit reached an unprecedented average growth rate of nearly 42 percent per annum.

In light of the above, this study investigates empirically the sustainability of the current account deficits in Turkey by considering nonlinear time series properties of the underlying data. While the empirical findings based on linear unit root tests turn out to be ambiguous, nonlinear unit root tests appear to point to nonstationarity in the current account deficit series based on the time series analysis of the quarterly data for the period Q1 1987 to Q3 2011.

The paper is organized as follows. Section 2 offers an overview of the relevant literature on current account sustainability. Section3 develops a dynamic model of the current account and its intertemporal budget constraint. Section 4 reports the findings of nonlinearity tests. In Section 5 the stationarity issues are discussed in light of the Caner and Hansen (2001) unit root test. Section 6 discusses the systemic reasons behind increasing current account deficits in the Turkish economy and policy implications of the econometric results. Finally in Section 7, we provide some concluding remarks.

2. Current account dynamics and sustainability

Increasing US current account deficits during the last decade have prompted a voluminous literature on the analysis of current account dynamics and its sustainability from various perspectives – see, among others, Wickens and Uctum (1993); Hakkio (1995); Milesi-Ferretti and Razin (1996), Coakley, Kulashi, and Smith (1998) Fountas and Wu (1999); Ventura (2001); Cooper (2001); Taylor (2002); Christopoulos and Leon-Ledesma (2010); Obsfeld and Rogoff (2004). The study of increasing current account deficits in the US economy was, in fact, parts and parcels of a deeper theoretical puzzle in open economy macroeconomics: why does international capital flow more to capital- rich economies, instead of finding its ways into capital- poor countries, as predicted by standard theories of international trade – the so called Lucas Paradox.

The findings of the relevant literature as to the sustainability of the US external deficits have been mixed; and most of the econometric results have pointed to the dangers of maintaining large deficits for the US economy in the long run. The methods used in these studies vary from vector autoregressive VAR models to univariate time series regressions. Because the specification of the models used is mostly linear and depends on several assumptions and parametric conditions, the results obtained are often difficult to interpret in the face of strong nonlinearities in the current account series. In this context, Otto (1992) considers the US and the Canadian cases, Chortareas Kapetanios, and Uctum (2004) analyze sustainability of the current account in some Latin American countries by using nonlinear unit root tests. Furthermore, instead of a univariate time series approach, some other studies have also relied on panel data analysis – see for instance, Wu (2000) and Wu, Chen, and Lee (2001).

In a similar vein, a number of recent studies have investigated the dynamics of current account deficits in Turkey. Togan and Ersel (2004), for instance, consider the Turkish current account in relation to the real exchange rate and the evolution exchange rate regimes in Turkey.

Akcay and Ucar (2006) provide an assessment of the rising external deficit in the context of previous balance of payments crises in Turkey. Cakmak and Varlik (2007) discuss the sustainability of Turkish external deficits in comparison with the Mexican experience. Kasman, Turgutlu, and Konyali (2005) focus on the relationship between overvalued Turkish Lira and the increasing current account deficits. Polat (2011) analyzes the sustainability of the current account deficits in Turkey by means of an autoregressive distributed lag model to test for cointegration between imports together with net interest payments and exports. None of these papers, however, scrutinized the nonlinear properties of the underlying data generating process.

3. The intertemporal model

To obtain a tractable dynamic model of the Turkish current account, we follow here the analysis of Taylor (2002), which defines current account sustainability as the ability of an open economy to satisfy its long-term intertemporal budget constraint. In terms of dynamic behavior of the budget constraint, this implies that the current account should be stationary, or more specifically weakly-stationary.

In a stochastic model with C_t, I_t, G_t, D_t, *and* Y_t denoting respectively consumption, investment, government spending, net stock of debt, and income; and i_t denoting the interest rate in international markets, it is possible to write a one-period budget constraint of the Turkish economy as

$$C_t + I_t + G_t + D_t = Y_t + (i_t + 1)D_{t-1} \qquad (1)$$

One can simplify Eqn. (1) by defining the net exports as

$$NEX_t = Y_t - (C_t + I_t + G_t)$$

Then Eqn.(1) can be written as,

$$D_t = (i_t + 1)D_{t-1} + NEX_t \qquad (2)$$

Taking the conditional expectation of the international interest rate i_t to be constant, given the information set at time $(t-1)$, we get,

$$E\left(i_t \,|\phi_{t-1}\right) = i \qquad (3)$$

Using Eqn.(3) and iterating Eqn.(2) forward, we obtain

$$D_t = \sum_{j=0}^{\infty}\left(\frac{1}{1+i}\right)^j E\left(NEX_{t+j} \,|\phi_{t-1}\right) + \lim_{T\to\infty}\left(\frac{1}{1+i}\right)^T E\left(D_{t+T} \,|\phi_{t-1}\right) \qquad (4)$$

The first term in the right-hand side of Eqn. (4) is the present-value of the future net exports surpluses; the second term is the expected stock of debt as T approaches infinity.

Clearly, for a sustainable current account, the present value of the expected stock of debt should be zero. This is the transversality condition of the optimal control problem the open economy is faced with in the long run. Hence sustainability implies that

$$\lim_{T\to\infty}\left(\frac{1}{1+i}\right)^T E\left(D_{t+T} \,|\phi_{t-1}\right) = 0 \qquad (5)$$

It is possible to show that for Eqn. (5) to hold, $(D_t - D_{t-1}) \equiv CA \equiv$ Current Account should be weakly stationary. Similarly, when there is positive growth in the economy, the sustainability condition requires that the share of current account in the total output (income) of the economy, that is, $\frac{CA_t}{Y_t}$, be weakly stationary.

4. The data and nonlinearity tests

To test for non-linearity in the current account data, we use quarterly seasonally adjusted data provided by the International Financial Statistics of IMF and the Central Bank of the Republic of Turkey. The data set spans the period from Q1 1987 to Q3 2011. The quarterly data for $\frac{CA}{GDP}$ is plotted in Figure 1. In Figure 2 the histogram of the CA/GDP series and the associated descriptive statistics are given. Figure 3 displays the sample autocorrelation function of the series.

(Figure 1., Figure 2. and Figure 3. about here)

The range of the series is 0.156. The positive skewness value along with the kurtosis being less than 3 indicate that the series is not normally distributed. This observation is confirmed by the Jarque-Bera normality test in which with a p-value of 47 percent, we reject the hypothesis that the distribution is normal. The correlogram in Fig. 3 reveals some autocorrelation. In other words, there appears to be some linear dependence in the *CA/GDP* series, although the autocorrelation function is far from being characterized by a hyperbolic decay. On the other hand, when some well-known nonlinearity tests are applied, an entirely different picture emerges from the analysis. The results of the McLeod-Li (1983), Bispectrum test of Hinich (1982), and

Tsay (1986) tests are given in Table 1: they all reject the null of linearity very strongly, which implies that there is strong nonlinear dependence in the quarterly CA/GDP series.

(Table 1. about here)

We also apply the BDS test of temporal dependence due to Brock, Dechert, and Scheinkman, and LeBaron (1996). The results of the BDS test given in Table 2 strongly reject temporal independence. Since we already know from the correlograms of the current account series that there is some linear dependence, these results demonstrate that the series also contains strong nonlinear dependence. To better isolate nonlinear dependence in the series, it is possible to filter the original CA/GDP series by a linear AR(p) or ARMA(p, d, q) model and then apply the BDS tests to the residuals. This is not done in this paper in view of space limitations.

(Table 2. about here)

5. Sustainability of the external deficit: Testing for nonstationarity

There exists a voluminous literature in time-series econometrics about unit roots, which is aimed at testing for weak stationarity in time series data. Classical unit root tests due to the pioneering work by Dickey and Fuller (1979), and (1981); Phillips-Perron (1988), and several other more refined tests, which take into account some particularities of the observed series including structural breaks and time trends, have been extensively used in empirical studies to test for stationarity; they can, in principle, be all used to test for stationarity in the $\frac{CA_t}{Y_t}$ time series for the Turkish case.

Yet all these tests are essentially linear tests with very low-power against unit roots close to unity. As argued above, the current account series, however, contain strong nonlinearities. For this reason, the conventional unit root test may give rise to incorrect results. It is no wonder that several previous studies reported conflicting results based on traditional linear unit root tests when applied to current account deficit series-see, for instance, Chortareas et al. (2004). To the quarterly current account data, we apply three commonly used linear unit root tests, including Augmented Dickey-Fuller (ADF); Phillips-Perron (PP); and Dickey-Fuller generalized least squares (DF-GLS) proposed by Elliott, Rothenberg, and Stock (1996). The results are reported in Table 3. As is well known, for all these three tests, the null hypothesis is that the time series contains a unit root. The results, as expected, are mixed. While the PP test appears to strongly reject the unit root (nonstationarity) under the null whether or not a time trend is added, the ADF test seems very sensitive to the time trend. On the other hand, the DF-GLS test does not reject the null at the one percent significance level while it rejects the null at the five percent level.

(Table 3. about here)

In order to go beyond the paradigm of linear unit root tests, one may use some of the recently developed nonlinear unit root test in time series econometrics. One may consider, for instance, three such tests available in the extant literature, namely the LNV test due to Leybourne, Newbold and Vougas (1998), the Threshold Unit Root test due to Caner and Hansen (2001), and the ESTAR test due to Kapetanios, Snell, and Shin (2003). In our study, we test the unit root in a two-regime threshold AR (p) (hence TAR(p)) model proposed by Caner and Hansen (2001) in which both nonstationary and nonlinear effects are allowed, as we observe some autocorrelation and nonlinearity in the current account series. Following Caner and Hansen (2001), we construct a TAR (p) model as:

$$\Delta ca_t = \theta_1{}' x_{t-1} 1_{\{Z_{t-1}<\delta\}} + \theta_2{}' x_{t-1} 1_{\{Z_{t-1}>\delta\}} + e_t \quad (6)$$

In Eqn. (6) $ca_t = CA_t/Y_t$, $x_{t-1} = \left(ca_{t-1}, r_t{}', \Delta ca_{t-1} \dots \Delta ca_{t-p}\right)$ in which r_t is a vector of deterministic components including an intercept (and maybe a time trend), $1_{\{.\}}$ is the indicator function with $Z_{t-1} = ca_{t-1} - ca_{t-(m-1)}$ where $m = 1 \dots p$ is the delay order, and e_t is an iid distributed error term. The vectors of parameters are:

$$\theta_1 = \begin{pmatrix} \rho_1 \\ \beta_1 \\ \alpha_1 \end{pmatrix}, \theta_2 = \begin{pmatrix} \rho_2 \\ \beta_2 \\ \alpha_2 \end{pmatrix} \quad (7)$$

In Eqn. (7) ρ_1, ρ_2 are scalar controlling the stationarity of the series, β_1, β_2 have same dimension as r_t, and α_1, α_2 are the slope coefficients on $\left(\Delta ca_{t-1} \dots \Delta ca_{t-p}\right)$ in two regimes.

As Caner and Hansen (2001) indicate, the threshold parameter δ is unknown but it takes values in the range of $[\delta_1, \delta_2]$. In this paper following most studies we consider two ranges, $[.15, .85]$, and $[.10, .90]$, respectively. In terms of the lag order p, as we use quarterly data, we consider p=3,4,5,6.

We first test whether or not there is a threshold effect, i.e. $H_0: \theta_1 = \theta_2$. As discussed in Caner and Hanser (2001), the test above is the standard Wald statistic which can be written as,

$$W_T = T\left(\frac{\widehat{\sigma_0}^2}{\widehat{\sigma}^2} - 1\right) \quad (8)$$

In Eqn. (8) $\hat{\sigma}^2$ is the residual variance from the TAR model, and $\widehat{\sigma_0}^2$ is the residual variance from the null linear model. As the presence of nonstationarity makes the asymptotic distribution depend on the data structure, the critical values cannot be tabulated. Therefore Caner and Hansen (2001) consider a bootstrap method to approximate the null distribution of W_T, hence calculate the critical values and p-values. We employ their method, and the results are reported in Table 4. The top panel represents the results using region $\delta = [.15, .85]$, and the bottom panel displays the results using the region $\delta = [.10, .90]$. In the top panel, we find the null of linearity is rejected at the 5 percent significance level at m=3 when the lag order p is set as 3,4,6, while it is rejected at m=4 when the lag order is p=4. Overall, the null is always rejected at 5 percent significance level at some delay order, suggesting that there exists threshold effect in the series.

(Table 4. about here)

For a unit root test the null hypothesis is

$H_0: \rho_1 = \rho_2 = 0.$

If the null holds, then the current account series $\frac{CA_t}{Y_t}$ has a "unit root" and is nonstationary.

A natural alternative to H_0 is

$H_1: \rho_1 < 0, \rho_2 < 0.$

If H_1 holds, then the time series $\frac{CA_t}{Y_t}$ is stationary.

However, as we are studying a two-regime threshold autoregressive model, a partial unit root needs to be considered, hence another alternative is

$H_2: \rho_1 < 0, \rho_2 = 0 \; or \; \rho_1 = 0, \rho_2 < 0$.

If H_2 holds, then the time series $\frac{CA_t}{Y_t}$ is stationary in one regime, but has a “unit root” in the other, and overall the series is nonstationary.

As discussed in Caner and Hansen (2001), the standard two-sided Wald statistic has less power because the alternatives H_1 and H_2 are one-sided. Following their study, we apply the one-sided Wald test,

$$W_{1T} = t_1^2 1\{\hat{\rho}_1 < 0\} + t_2^2 1\{\hat{\rho}_2 < 0\}$$

As mentioned earlier, under the null, the series is nonstationary. If the null is rejected, then we need to determine whether the series is stationary or has a partial unit root, i.e., H_1 or H_2. As Caner and Hansen (2001) suggest, the decision can be made by checking the individual $-t_1$ and $-t_2$ If only one of these negative values is significant, then we conclude that the series have a partial unit root, i.e. H_2. Otherwise it is stationary, i.e., H_1.

Table 5 reports the results for each delay parameter m from 1 to p with p=3,4,5,6. As the results using $\delta = [.15, .85]$ and $\delta = [.10, .90]$ display similar patterns, we only report the results using $\delta = [.15, .85]$ due to space limitation. We find that all test statistics for the one-side Wald test are less than the one percent critical values, hence fail to reject the null hypothesis of nonstationarity. Furthermore, the results of both individual t-statistic tests, t_1 and t_2, cannot reject $\rho_1 = 0$ or $\rho_2 = 0$, implying that the current account series is nonstationary.

(Table 5. about here)

6. The balance of payments in the very long run: policy options

Balance of payments statistics summarize the transactions of a country with the rest of the world; as such, the mere existence of large current account deficits in an open growing economy does not necessarily imply macroeconomic instability as long as international borrowing is used for productive investment. A historical comparison may be helpful in this context. Canada and Australia, for instance, since the late nineteenth century have run persistent current account deficits, at times exceeding 10 percent of their GDPs. Post-war current account data also reveal that both of these countries have continued to grow with substantial deficits. Nevertheless, the creditworthiness of these countries in international capital markets did not suffer; external borrowing, unlike in Latin American economies in the early 1980's, went smoothly without seriously destabilizing macroeconomic equilibria. Indeed, Canada's trade surpluses, and Australia's policy reforms *pari passu* with their sound institutional infrastructures appear to have contributed to the sustainability of their current account deficits. Does this imply, therefore, that there is some evolutionary process in economic development, whereby the balance of payments of growing economies pass through various stages? If so, what are the characteristics of these stages in terms of the current/trade accounts and net foreign investment positions of these economies?

By the second half of the nineteenth century, with the rise of the British Empire as the world hegemonic power, economists took interest in the analysis of the long run trends in balance of payments statistics. Cairnes (1874) is probably the first economist who hypothesized the existence of stages in the balance of payments while discussing the borrowing requirements of colonies. In its simplest version, the so-called "stages hypothesis" posits that a developing economy starts as a young borrower-debtor (with a trade deficit financed by foreign borrowing) and progresses gradually to a mature creditor (with a trade deficit financed by returns on accumulated international assets). Subsequently, other attempts to account for this alleged "stages phenomenon" came from Taussig (1928) and Crowther (1957), each one conjecturing different number of stages. Fischer and Frenkel (1972) showed that the balance of payments of a growing economy may generate cycles that are consistent with the stages hypothesis. Bazdarich (1978) was the first who provided a direct challenge to the stages hypothesis; he demonstrated that in competitive world capital markets, the optimal growth of a small economy would reveal no tendency to pass through such stages and that a developing economy would always be a net borrower - with its external debt increasing monotonically to a steady state level. Neither various versions of the stages hypothesis, nor the "stylized facts" based on observations of several financial crises in the world economy during the last four decades, however, seem to provide clear-cut answers to the question of sustainability of current account deficits in the very long run. Indeed, it would be hard to rationalize the evolution of the balance of payments of Turkey within this "theory" of a life cycle of borrowing and repayment.

Widely regarded as a poster boy of the Washington Consensus during the 1980's, the Turkish economy has remained caught between the S*cylla* of high inflation and *Charybdis* of high interest rates for the following two decades – see Yeldan (1989) for a detailed analysis of alternative growth policies. Since the 2001 financial crisis, thanks to high real interest rates, fast privatization and fiscal discipline, Turkey has been a favorite destination of foreign capital inflows - both in the forms of portfolio and direct foreign investment –see, Voyvoda & Yeldan (2005). While it appears that parts of the credits have been used for investment purposes, there is also some evidence that large volumes have been used for excessive consumption – see, Ogus and Sohrabji (2006). Hence, despite relatively high but erratic real growth rates, unemployment in Turkey has remained above 9 percent for nearly a decade.

So far as the current account deficit is concerned, the general pattern that subsequently emerged is that the Turkish external balances haves erratically exhibited surpluses during the crisis periods in the world and domestic economy, whereas under favorable international conditions, encouraged by the rapid inflow of hot money, current account deficit has continued to widen since 2002. It is important, in this context, to note that for the period 2004-2011, while the average inflation in the world economy was around 59.5 percent, for the same period, the Turkish inflation rate has been 72.5 percent, despite a successful exchange- rate based stabilization program in 1999. It is clear that this double-digit domestic inflation, together with an overvalued Turkish Lira reduced the competitiveness of Turkish manufacturing in export markets, hence contributed to the widening of trade deficits. Domestic production, meanwhile, grew at an average annual rate of 3.9 and 4.8 percent for the two sub-periods of 2001-2010 and 2003-2010, exhibiting a strong correlation with imported intermediate and investment goods series.

World Bank (WB) statistics reveal that the saving rates (as percentage of GDP) in the middle-income countries for the 1990-2009 period show an upward trend from over 25 percent to 30 percent, savings in Turkey declined from 22 percent to below 15 percent – WB World Economic Indicators (2011). It can be argued that the sharp output decline in the order of -4 percent in the aftermath of the Great Recession was the result of this structural dependence on international financing. Similarly, despite a sharp real depreciation of the Turkish Lira in the mid- 2011, the current account deficit remained over 10 percent of GDP. The deficit started gradually to decrease only after the full impact of the Euro zone crisis had been felt in international financial markets by the beginning of 2012.

That low domestic savings together with overvalued currency and relatively high inflation harm, in the long run, the competitiveness of export sectors in Turkey is well recognized. Yet a more fundamental factor that affects the value- added of export goods, hence the competitiveness of the Turkish economy in international markets, is the level and composition of human capital in Turkey. The paucity of high-tech, high value - added products in the lists of export items in Turkey unequivocally demonstrates that what is missing in the growth dynamics of the Turkish economy is a Human Development Index akin to those of the countries that rank, at least, among the top fifty world economies – see, UNDP (2011) Human Development Report. With a mean years of schooling (of adults over 25 years) of 6.5, and a public expenditure of 2.6 percent of GDP, the neoclassical "growth convergence" will take a long time to materialize.

7. Concluding remarks

This empirical investigation is aimed at studying current account dynamics in Turkey, with an eye towards understanding its long- run evolution. More specifically, using quarterly data, we have attempted to see if the transversality condition would hold in the long run by testing for stationarity of the current account series. Because the current account series contains strong nonlinearity, we have relied on the results of Caner and Hansen (2001), which revealed nonstationarity in the current account series.

It is important to note here that the onset of the global recession, which represents a genuine "regime shift" in the external balances of national economies, did not seem to have structurally modified the long run dynamics of the Turkish current accounts. In this context, it is also interesting make the following two observations. First, a large portion of the trade deficit of the Turkish economy is due to imported petroleum and energy products whose prices have declined in the aftermath of the 2008 financial meltdown. Second, unlike in many other emerging market economies, the real estate markets in Turkey, being less dependent on the global mortgage markets, have not been a catalyst in propagating the global contraction across domestic markets. Yet, neither of these positive developments appears to have affected the current account dynamics in Turkey.

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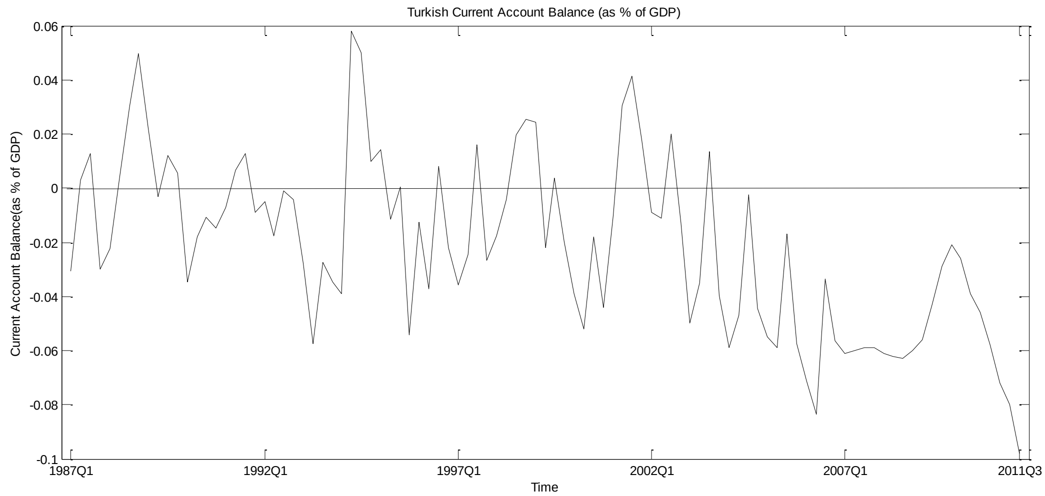

Figure 1. Plot of CA/GDP series from Q41987 through Q32011. **Source**: IMF International Financial Statistics and the Central Bank of the Republic of Turkey.

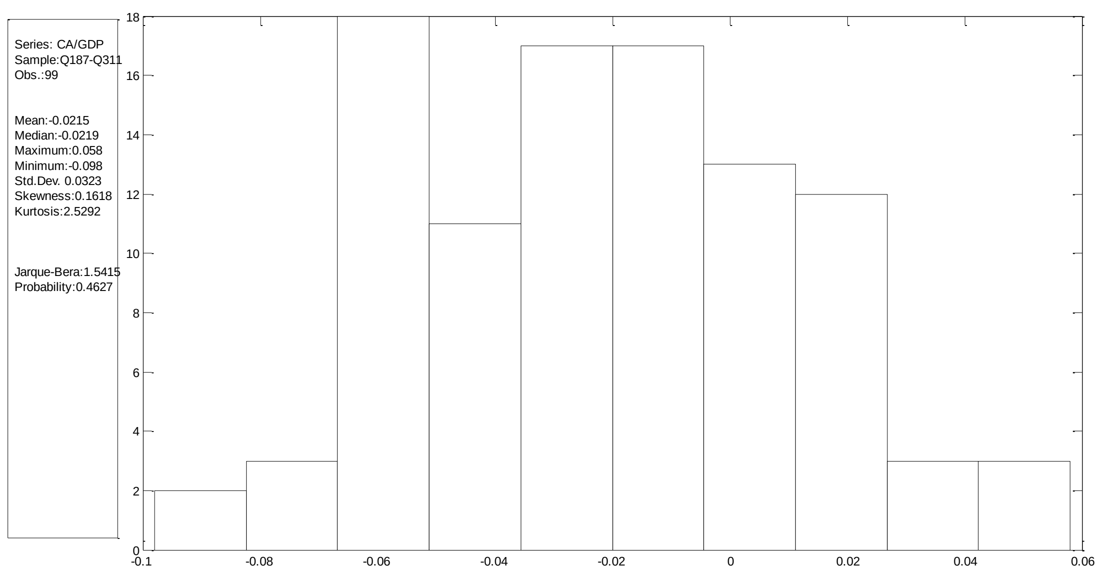

Figure 2. The histogram of CA/GDP series.

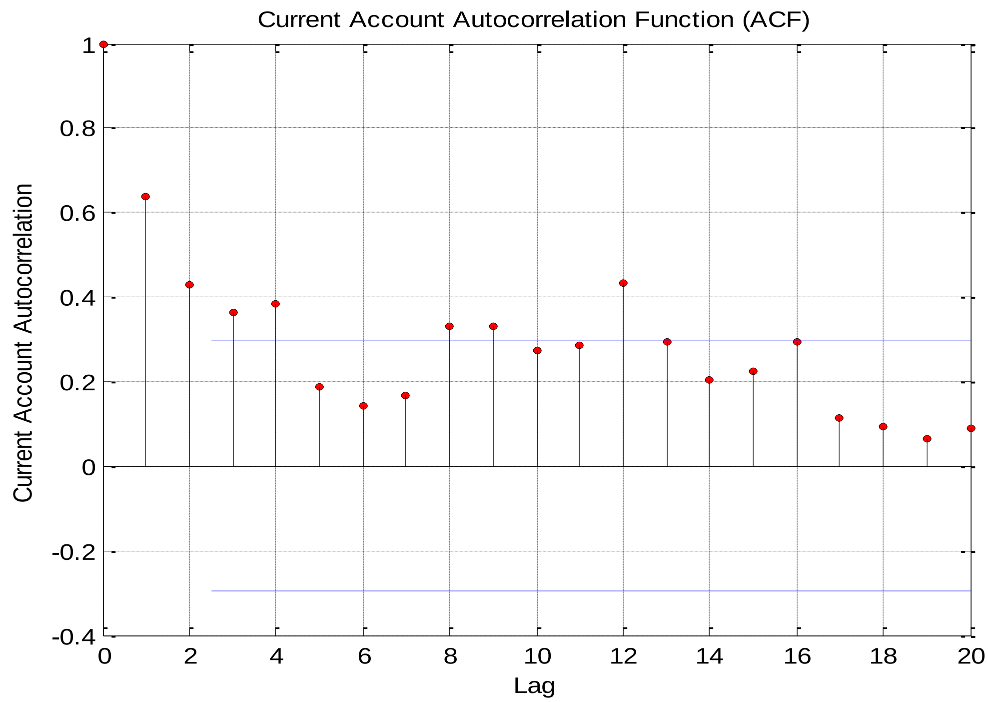

Figure 3. The Sample Autocorrelation Function (ACF) of CA/GDP series

Table 1. *Significance Levels of the Nonlinearity Tests*

MLL	BC	T
0.01	0.02	0.00

Note: MLL=McLeod- Li Test; BC=Bispectrum Test; T=Tsay Test

Table 2. *BDS Test Results*

ε	0.25	0.75	1.00
M=2	5.23	7.20	8.10
M=3	7.67	10.15	10.20
M=4	9.52	15.25	18.23
M=5	22.15	28.17	32.15
M=6	37.80	39.75	41.18
M=7	45.85	62.12	71.15
M=8	67.10	75.16	81.03

Note: M= Embedding Dimension; ε the radius of the comparison ball in terms of the standard deviation of the series.

Table 3. *Linear Unit Root Tests*

	Constant	**Constant and Time Trend**
PP	-4.083**	-5.813**
ADF	-2.513	-4.752**
DFGLS	-3.402*	-3.402*

Note: PP=Phillips-Perron Test; ADF=Augmented Dickey-Fuller Test; DFGLS=Dickey-Fuller Generalized Least Squares Test. **Statistically significant at 1% level, * Statistically significant at 5% level.

Table 4. *Bootstrap Threshold Test*

$\delta = [.15, .85]$

p=3			p=4			p=5			p=6		
m	W_T	5%C.V.	m	W_T	5%C.V	m	W_T	5%C.V	m	W_T	5%C.V
1	11.24	19.52	1	18.82	22.26	1	17.62	25.14	1	19.78	27.83
2	6.94	19.39	2	10.13	22.19	2	10.43	24.51	2	12.66	27.58
3	24.32*	19.38	3	21.07	22.20	3	30.67*	24.47	3	31.94*	28.28
			4	24.78*	21.96	4	24.00	24.75	4	26.59	27.48
						5	11.12	24.53	5	11.09	27.35
									6	14.05	27.64

$\delta = [.10, .90]$

p=3			p=4			p=5			p=6		
m	W_T	5%C.V.	m	W_T	5%C.V	m	W_T	5%C.V	m	W_T	5%C.V
1	11.41	20.61	1	18.82	25.35	1	17.63	27.90	1	19.79	31.56
2	7.76	20.57	2	10.13	24.77	2	10.43	28.11	2	12.66	31.35
3	24.32*	20.67	3	21.07	25.15	3	30.67*	28.44	3	31.94*	31.27
			4	24.78*	24.67	4	24.00	27.76	4	26.59	31.00
						5	11.33	28.16	5	12.25	31.43
									6	14.05	30.67

Note: δ =threshold parameter, p=lag order, m=delay order, W_T =the standard Wald statistic, 5%C.V.=5 percent critical value.

Table 5. *Unit Root Tests of Threshold Autoregressive Model*

P = 3

	1-Side Wald Test		t_1 Test		t_2 Test	
m	W_{1T}	1% C.V.	t-stat	1% C.V.	t-stat	1% C.V.
1	4.36	18.62	2.09	3.75	-0.76	3.89
2	2.69	18.30	0.65	3.75	1.50	3.90
3	9.05	18.89	1.54	3.80	2.58	3.92

P = 4

	1-Side Wald Test		t_1 Test		t_2 Test	
m	W_{1T}	1% C.V.	t-stat	1% C.V.	t-stat	1% C.V.
1	8.03	20.33	2.06	4.01	1.95	4.10
2	6.95	19.96	0.34	3.95	2.61	4.02
3	11.35	20.65	1.72	3.93	2.90	4.14
4	3.75	22.00	1.68	3.98	0.95	4.23

P = 5

	1-Side Wald Test		t_1 Test		t_2 Test	
m	W_{1T}	1% C.V.	t-stat	1% C.V.	t-stat	1% C.V.
1	6.39	19.14	2.18	3.86	1.28	3.86
2	3.93	18.97	1.03	3.87	1.69	3.88
3	10.84	20.02	2.28	3.95	2.38	3.94
4	2.68	20.32	1.48	3.97	0.69	4.05
5	3.65	20.18	-0.21	3.89	1.91	4.02

Table 5. (*Continues*)

P = 6

	1-Side Wald Test		t_1 Test		t_2 Test	
m	W_{1T}	1% C.V.	t-stat	1% C.V.	t-stat	1% C.V.
1	5.70	19.51	1.85	3.90	1.51	3.91
2	3.13	19.40	0.16	3.83	1.76	3.87
3	9.09	19.16	1.96	3.93	2.29	3.85
4	1.59	20.04	0.58	3.94	1.12	3.94
5	3.94	20.30	-0.26	3.89	1.98	4.02
6	3.39	20.28	-0.13	3.98	1.84	3.98

Note: p=lag order, m=delay order, W_{1T} =one side Wald statistic, 1%C.V.=1 percent critical value.